UPPER CLARK FORK BASIN WATER RESERVATION APPLICATIONS

Draft Environmental Impact Statement

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

TED SCHWINDEN GOVERNOR

1520 EAST SIXTH AVENUE

STATE OF MONTANA

DIRECTOR'S OFFICE (406) 444-6699

HELENA, MONTANA

NOTICE

DECEMBER 16, 1988

The Department of Natural Resources and Conservation (DNRC) recently completed its draft environmental impact statement (DEIS) on reservations of water in the Clark Fork basin above Milltown Dam. Reservations of water are sought by the Granite Conservation District and the Montana Department of Fish, Wildlife and Parks. Copies of this DEIS are being circulated for public review and comment for 60 days, ending February 13, 1989.

Persons making written comments should address comments to:

John Tubbs
re: Clark Fork Reservations
Department of Natural Resources and Conservation
Water Resources Division
1520 East Sixth Avenue
Helena, MT 59620-2301

In addition, public meetings will be held to receive written or oral comments on the DEIS. The schedule for the public meetings is:

Drummond Community Hall	January 16, 1989	7:00 P.M.
Deer Lodge Elementary School	January 17, 1989	7:00 P.M.
Bonner Grade School	January 18, 1989	7:00 P.M.

The Upper Clark Fork Water Reservations Proceedings DEIS and this notice were prepared pursuant to the Montana Environmental Policy Act and the Montana Water Use Act. Copies of the DEIS and this notice were filed with the Governor and the Environmental Quality Council on December 16, 1988. Additional copies of this DEIS can be obtained by calling (406) 444-6832, or by writing to DNRC at the address listed above.

Sincerely,

John Tubbs
Economist
Water Management Bureau

Draft Environmental Impact Statement

FOR WATER RESERVATION APPLICATIONS IN THE

UPPER CLARK FORK BASIN

December 1988

Montana Department of Natural Resources
and Conservation

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SUMMARY

This document presents an evaluation by the Department of Natural Resources and Conservation (DNRC) of the environmental and economic consequences of reserving water in the tributaries and main stem of the Clark Fork of the Columbia River above Milltown. The Montana Department of Fish, Wildlife and Parks (DFWP) has applied for water that would be reserved in the natural stream channels to protect fish, wildlife, recreational resources, and water quality. The Granite Conservation District (GCD) has requested a reservation of water in the North Fork of Lower Willow Creek for a future irrigation project.

The Board of Natural Resources and Conservation (Board) is responsible for deciding whether the requested reservations should be granted. Under the terms of the Montana Water Use Act, applicants for water reservations must establish:

a. the purpose of the reservation,
b. the need for the reservation,
c. the amount of water necessary for the reservation, and
d. that the reservation is in the public interest.

After considering the applications and pertinent information, including testimony from the public, the Board has the authority to grant all, part, or none of the water requested. This document examines the effects of granting DFWP and GCD the full amount of water requested or a lesser amount, or of granting no water at all to either applicant.

Granting the instream reservations requested by DFWP would tend to preserve flows as they are at present, causing no substantial additional impacts to the environment. Existing water rights would maintain their seniority and would not be affected. Present low flow conditions would continue. If granted, however, the instream reservations would be senior to any subsequent applications to use water for consumptive purposes such as irrigation.

If GCD's reservation is granted, impacts to the environment would not occur until project construction begins. Based on information in GCD's application, some of the impacts are predictable and are analyzed in this draft EIS. But the extent of other, site-specific impacts cannot be estimated until engineering and operating plans are finalized. This dam, which GCD expects to build in the years 2002 and 2003, would primarily capture high spring flows for supplemental irrigation on 2,900 acres of land that currently are irrigated to the extent possible with water from the existing reservoir on Lower Willow Creek.

The proposed North Fork of Lower Willow Creek project could improve the productivity of the irrigated land and enhance the income of about 20 family ranching operations. Although these benefits seem small, they would be significant in a sparsely populated area like the upper Clark Fork basin, which has been losing population as a result of shutdowns or cutbacks in the mining and industrial sectors and from the consolidation of ranching

operations and mechanization of ranch labor. The GCD project also could have some minor environmental benefits because it would increase flows in Lower Willow Creek, Flint Creek, and the main stem Clark Fork during several months of the year. Water levels in the existing Lower Willow Creek Reservoir would be stabilized by releases from GCD's proposed reservoir.

DNRC's estimate of dam costs is significantly higher than GCD's ($9,969,976 versus $2,859,400). The disparities between the DNRC cost estimates and those of GCD are primarily in the probable costs of the spillway and outlet works. DNRC performed a thorough analysis and the project was not found to be feasible regardless of the dam costs used.

The North Fork of Lower Willow Creek project would be even less feasible if GCD were granted less water than it applied for, so DNRC did not perform a detailed analysis on the effects of a reservation smaller than that requested for GCD.

DNRC's analysis indicated that fish, wildlife, and recreational resources could be protected to an extent if DFWP received a reservation smaller than it requested, but the degree of protection would be reduced.

It is not clear what would happen if the Board were to grant no water to either applicant. DNRC could continue to issue water use permits for consumptive water uses in the upper basin, as it does now, and streams could become increasingly depleted. In actuality, however, this would not be likely to occur indefinitely, even if the Board took no action to prevent it. Such depletions might eventually be limited by holders of downstream water rights. The Montana Power Company has claims to 2,000 cubic feet per second (cfs) at its Milltown Dam facility, and Washington Water Power holds claims and permits totaling 50,000 cfs at its Noxon Rapids Dam. These facilities are able to divert nearly the entire natural flow of the Clark Fork and its headwaters in most years. Flows greater than 50,000 cfs are available only during spring runoff, and then only in some years. While consumptive uses have occurred upstream without intervention from these possible constraints, future consumptive development may have to rely on storage of higher spring flows.

This draft EIS includes DNRC's preliminary recommendations, stated in Chapter Eight, to inform the public of DNRC's present position on DFWP's and GCD's requested reservations. Public comment on DNRC's position is encouraged. DNRC's recommendations on DFWP's and GCD's reservations will not be finalized until after the Board hearing.

ABBREVIATIONS

af	--	acre-feet
ARCO	--	Atlantic Richfield Company
ARM	--	Administrative Rules of Montana
Board	--	Montana Board of Natural Resources and Conservation
BOD	--	Biological Oxygen Demand
cfs	--	cubic feet per second
COD	--	Chemical Oxygen Demand
DFWP	--	Montana Department of Fish, Wildlife and Parks
DHES	--	Montana Department of Health and Environmental Sciences
DNRC	--	Montana Department of Natural Resources and Conservation
DSL	--	Montana Department of State Lands
EIS	--	Environmental Impact Statement
EPA	--	United States Environmental Protection Agency
FERC	--	Federal Energy Regulatory Commission
GCD	--	Granite Conservation District
MEPA	--	Montana Environmental Protection Act
MNHP	--	Montana Natural Heritage Program
MPC	--	Montana Power Company
MRI	--	Montana Resources Incorporated
TSS	--	Total Suspended Solids
USBR	--	U.S. Bureau of Reclamation
USFS	--	United States Forest Service
WWP	--	Washington Water Power Company

CHAPTER ONE

INTRODUCTION

The purpose of this environmental impact statement is to examine the consequences of granting water reservations to the Granite Conservation District (GCD) and to the Montana Department of Fish, Wildlife and Parks (DFWP). Both of these public entities have applied to the Montana Board of Natural Resources and Conservation (Board) for reservations of water in the Clark Fork basin above Milltown. GCD seeks a reservation on the North Fork of Lower Willow Creek to provide supplemental water to 2,900 acres of currently irrigated land. DFWP's proposed reservation would protect instream flows on the Clark Fork and seventeen of its tributaries.

The Clark Fork of the Columbia River drains most of the land west of the Continental Divide in Montana. The surface water in this basin is subject to a complex array of water right claims and use permits, hereinafter referred to as water rights. In the upper basin, the majority of water rights are held by irrigators. Because of the priority dates associated with rights for irrigation on tributary streams, these rights might impose constraints to future consumptive uses on tributaries. Hydroelectric dams in the lower basin constitute the largest use of water in the entire Clark Fork basin. Due to the dams' downstream locations, and the seniority of water rights associated with the dams, eventually nearly all future consumptive water users also might be constrained by these existing hydroelectric operations. In short, future water availability is a pressing issue in the Clark Fork basin.

MONTANA WATER LAW AND RESERVATIONS

Water use in Montana is generally guided by the legal principle known as the prior appropriation doctrine, "first in time is first in right." A user's right to a specific quantity of water depends on when the use began. The first person to use water from a source established the first right, the second person was free to divert flows from what was left, and so on. During a dry year, the person with the earliest date of use would have first chance at the available water to the limit of his established right. The holder of the second earliest priority date would have the next chance, and so on.

After passage of the Water Use Act in 1973, a permit must be issued by DNRC in order for water users to obtain a water right. A general adjudication is being conducted statewide by the courts to determine the validity of claims for pre-1973 water rights. The nature and extent of these claimed rights will not be determined until a final court decree is entered. For the Clark Fork, a final decree specifying existing rights is not expected in the near future.

When the 1973 Legislature passed the Montana Water Use Act, it allowed the reservation of water for present and future beneficial uses such as irrigation, maintenance of instream flows, and the protection of water quality. "Instream flow" refers to water that is reserved to remain in its natural stream channel for the

benefit of fish, wildlife, or other purposes. Reservations for instream flow are limited to 50 percent of the average annual flow of record on gauged streams. There are no limitations on reserving flows in streams without gauges. Only state or federal agencies or political subdivisions of the state, including conservation districts, may apply to the Board for water reservations.

Although DNRC processes applications for reservations, the Board makes the decision to grant or deny a reservation. The Board may grant all or part of the water requested and may place conditions on the reservation. The Board may not grant a reservation unless an applicant satisfactorily establishes:

a. the purpose of the reservation,
b. the need for the reservation,
c. the amount of water necessary for the reservation, and
d. that the reservation is in the public interest.

The granting of a reservation establishes a legal right similar to other water rights in Montana. If set aside for irrigation, the water may go unused until the irrigation project is built or until a time specified by the Board has passed. An applicant must show diligence in putting the reserved flows to use. So far in Montana, reservations have been granted only in the Yellowstone River basin. In the Yellowstone reservations, the Board set a deadline of 30 years by which time the water reserved for consumptive purposes had to be put to beneficial use.

Once reservations are granted, only flows exceeding other water rights and those protected by the reservations will be available for future use. **Reservations cannot adversely affect water rights in existence at the time the reservation is granted.** However, a reservation can be used as a basis to object to future permits or changes in existing water rights. In deciding to grant all or part of the reservations or deny one or both of the reservations, the Board must determine how the reservations would affect existing water rights.

Unlike a water-use permit where the priority date is the date of application, the priority date for a reservation is the date the Board makes its decision. When the Board made its decision on reservations in the Yellowstone River basin, priority for each reservation was set by the time of day that the reservation was granted.

During its 10-year review, the Board may extend, modify, or revoke the reservation if it is shown that the objectives of the reservation are not being met. The Board may also reallocate an instream flow reservation to a qualified reservant if the Board finds that all or part of the reservation is not required for its purpose. The Board also must find that the need for the reallocation outweighs the need shown by the original reservant.

PHASED EIS PROCESS

This draft EIS was prepared to satisfy requirements under the Montana Water Use Act and the Montana Environmental Policy Act (MEPA). The EIS provides information for the Board to use in deciding whether it should grant, modify, or deny reservations applied for by GCD and DFWP. The Board must make a determination that granting a reservation will not adversely affect existing water rights and uses. Putting the reserved water to use may have additional environmental consequences, both adverse and beneficial.

No additional analysis of impacts resulting from DFWP's instream flow reservation requests is foreseen. In contrast, the analysis of impacts from GCD's proposed reservation on the North Fork of Lower Willow Creek presented in this EIS is preliminary. The analysis of GCD's proposal is based on information in GCD's application and other sources. If the Board should grant the reservation to GCD, final engineering design for the irrigation facilities would be required prior to construction. In time, full geotechnical investigations must be conducted and sites identified from which fill material for a planned dam would be taken. Also, land would have to be acquired and final design and operating plans prepared before a dam could be built. If a reservation is granted, GCD will conduct those detailed design studies, and expects that the project would

be built in the years 2002 and 2003. It is possible that a second, more detailed environmental impact statement would be required by agency actions prior to construction to satisfy the requirements of MEPA.

DNRC'S APPROACH TO THE PHASED EIS AND RESERVATION PROCESS

By law, DNRC may assist in preparing reservation applications. Such assistance does not necessarily mean that DNRC endorses the given reservation request. DNRC also reviews applications for water reservations and accepts them after determining that they are "correct and complete." Accepting a reservation application as correct and complete means that it contains enough information to conduct a thorough evaluation of the request. However, acceptance does not constitute an endorsement of the application.

When DNRC accepts an application for a reservation of water that may significantly affect economic or population growth or the quality of the environment, an environmental impact statement (EIS) must be prepared. Public meetings are then held to help determine the issues that should be examined in the EIS. State and federal agencies are also contacted to ascertain their concerns. Information gathered from the public and governmental agencies and information contained in the application are used to prepare a draft EIS examining important issues. This draft EIS is then circulated to the public for comment. After interested parties have had the opportunity to review the draft EIS, DNRC holds additional public meetings to gather written and oral comments. DNRC then evaluates the comments and determines whether any issues remain to be dealt with. The next step is publication of a "final" EIS containing DNRC's responses to comments and providing information on issues raised following publication of the draft EIS.

After the final EIS is published, DNRC issues formal legal notice as is done when a new water-use permit is requested, and accepts written objections to the proposed reservations. If valid objections are received, a hearings examiner is appointed by the Board and a formal contested case hearing is held. Testimony at this hearing is presented under oath and witnesses can be cross-examined. The hearings examiner accepts recommendations from the concerned parties, and then presents the findings and recommendations to the Board. Based on its review of this record, the Board decides to grant or deny all or part of the requested reservations.

COMMENTS RECEIVED ON PREPARATION OF THE DRAFT EIS

Early in 1987, DNRC asked state and federal agencies and other organizations what issues should be examined in the EIS. Written comments were received from the U.S. Forest Service, the Bonneville Power Administration, the City of Missoula, the U.S. Environmental Protection Agency (EPA), and the Flint Creek Water Users Association. Other state agencies that were asked about their concerns include the Department of Health and Environmental Sciences, the Department of Commerce, the Department of Agriculture (USDA), the Department of Revenue, and the Department of State Lands (DSL). County commissioners, local planners, representatives of irrigation districts, and water users' associations also were invited to participate.

DNRC also held public meetings in Anaconda, Drummond, and Bonner on March 30, 31, and April 1, 1987, to present information on the proposed reservations and to gather comments from landowners, water users, and other interested parties. Issues discussed include water availability and water rights, the possibility of leaving some water unallocated, and effects of stream dewatering on water quality and aquatic life, municipalities, hydropower producers, and industry. Participants discussed the benefits of irrigation developments, including jobs, benefits to the local economy, and increased recreational opportunities due to new reservoirs. DNRC used these comments to help decide which issues should be discussed in this EIS.

CHAPTER TWO

DESCRIPTION OF RESERVATIONS REQUESTED - THE PROPOSED ACTIONS

This chapter introduces each applicant's description of the purpose of its reservation requests and summarizes each applicant's explanation of why the reservations are needed and are in the public interest. DNRC's analysis of the impacts of granting the reservations is presented in Chapters Five through Seven.

The Department of Fish, Wildlife and Parks and the Granite Conservation District have filed applications before the Board of Natural Resources and Conservation for reservations of flow in the upper Clark Fork basin. DFWP's reservation requests are summarized in Table 2-1 and GCD's in Table 2-2. Figure 2-1 shows the location of streams where reservations are being requested. The Board may allocate all or part of DFWP's request for flows in the Clark Fork and tributaries for instream uses such as recreation, fish habitat, and preservation of water quality; allocate all or part of the flows for GCD's future irrigation project; or deny the requested reservations. Because GCD's and DFWP's applications compete for some of the same water, the Board, by granting one request before the other, may give one applicant priority over the other.

DFWP APPLICATION

DFWP seeks to reserve instream flows in the main stem of the Clark Fork and 17 of its tributaries. An instream flow reservation reserves water for retention in the stream after pre-existing water rights are satisfied. DFWP's two primary objectives are to provide year-round protection of aquatic habitat, and to maintain adequate tributary flows from January 1 to April 30 to dilute pollutants in the Clark Fork.

Purpose

The purpose of DFWP's requested reservation is to provide public benefits through:

1. the protection of fish and wildlife uses,
2. the protection of recreation,
3. the protection of water quality, and
4. the protection of the state and federal investment being made in pollution abatement in the basin.

Need

DFWP has stated that reservations are needed to maintain fish habitat, aquatic insect populations, aquatic plant and animal life that sustain fish, vegetation within the riparian zone, and associated wildlife. Water is needed to provide adequate stream flows for maintaining spawning and rearing areas, shelter for fish, and the production of food organisms for fish. Sufficient flows are also needed to prevent further deterioration of water quality in the Clark Fork during low-flow periods.

Water quality in the Clark Fork has been degraded by past mining activities in the upper basin. Water in the Clark Fork contains several metals, most notably copper, which are toxic to fish. Besides metal toxicity problems, dissolved oxygen levels are depressed in summer months. In several low-flow years, dissolved oxygen levels

Table 2-1. DFWP's Reservation Requests[a].

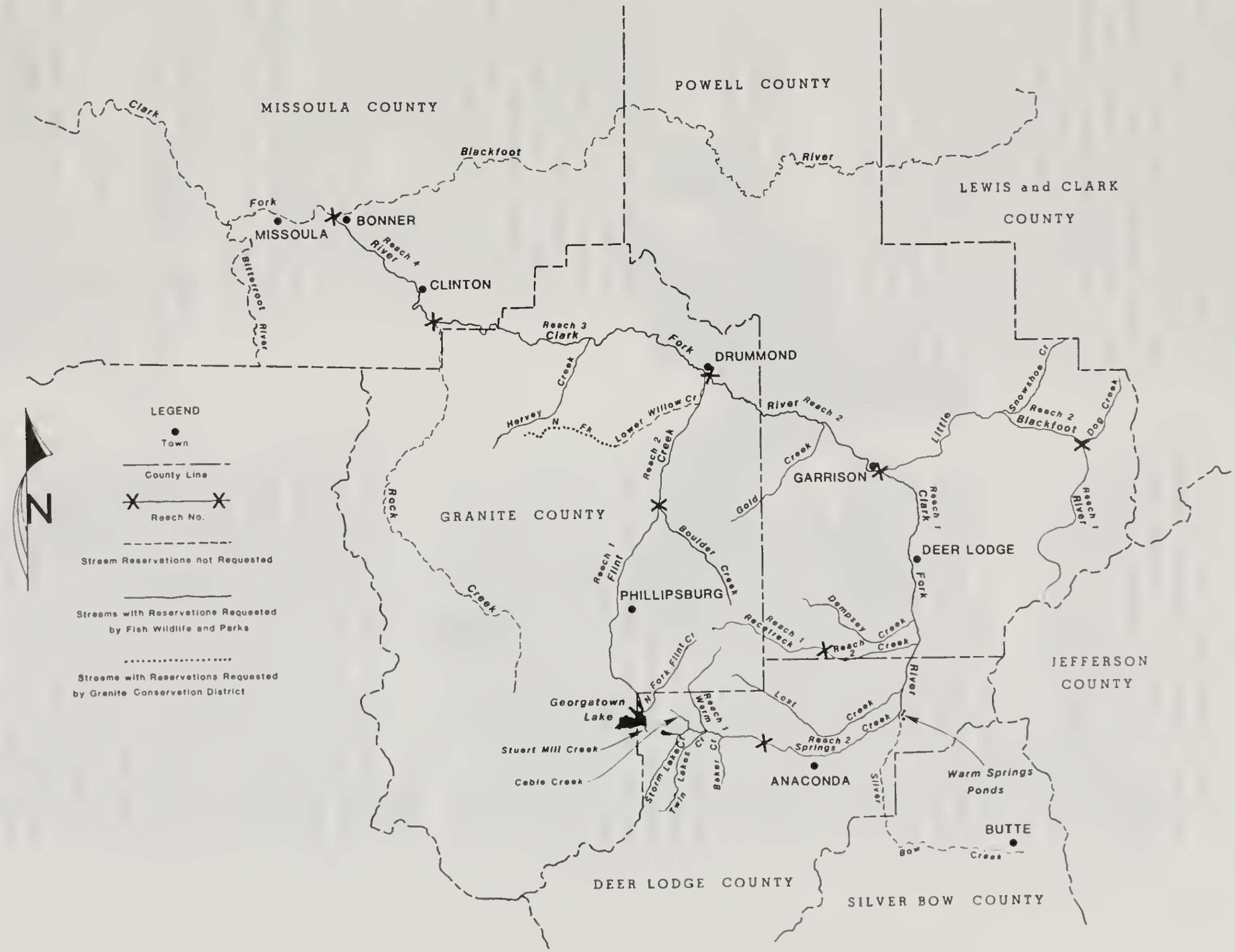
Stream Name	Length of Stream Reach (Miles)	Flows and Volume of Water Requested Year Round	Instream Flows for Water Quality Jan. 1 to April 30
MAIN STEM			
Clark Fork main stem			
Reach 1 (Warm Springs Creek - Little Blackfoot River)	37.8	180 cfs 130,314 af	none
Reach 2 (Little Blackfoot River - Flint Creek)	28.1	400 cfs 289,587 af	none
Reach 3 (Flint Creek - Rock Creek)	35.8	500 cfs 361,983 af	none
Reach 4 (Rock Creek - Milltown)	17.2	600 cfs 434,380 af	none
TRIBUTARIES			All of the instantaneous base flow, subject to existing, lawfully appropriated water rights until such time as mine waste reclamation allows copper concentrations entering the Clark Fork above Warm Springs Creek to reach acceptable levels in downstream reaches. Flow is requested at each stream's confluence with the Clark Fork.
Warm Springs Creek			
Reach 1 (Confluence of Middle Fork Warm Springs Creek - Meyers Dam)	15.3	50 cfs 36,198 af	
Reach 2 (Meyers Dam - Mouth)	16.6	40 cfs 28,959 af	
Barker Creek	5.1	12 cfs 8,688 af	
Cable Creek	5.8	10 cfs 7,240 af	
Storm Lake Creek[b]	10.0	10 cfs 7,240 af 3 cfs 2,172 af	
Twin Lakes Creek	7.5	13 cfs 9,412 af	
Lost Creek	19.9	16 cfs 11,583 af	
Racetrack Creek			
Reach 1 (Confluence of North Fork Racetrack Creek-USFS Boundary)	9.3	26 cfs 18,823 af	
Reach 2 (USFS Boundary - mouth)	10.8	3 cfs 2,172 af	
Dempsey Creek	17.1	3.5 cfs 2,543 af	
Little Blackfoot River			
Reach 1 (Blackfoot Meadows - Dog Creek)	17.4	17 cfs 12,307 af	
Reach 2 (Dog Creek - mouth)	26.9	85 cfs 61,537 af	
Snowshoe Creek	9.2	9 cfs 6,516 af	
Dog Creek	15.5	12 cfs 8,688 af	
Gold Creek	15.0	34 cfs 24,615 af	
Flint Creek			
Reach 1 (Georgetown Lake - Boulder Creek)	28.0	50 cfs 36,198 af	
Reach 2 (Boulder Creek - mouth)	15.7	45 cfs 32,578 af	
Boulder Creek	13.4	20 cfs 14,479 af	
North Fork of Flint Creek	7.5	6 cfs 4,344 af	
Stuart Mill Creek	.3	14 cfs 10,136 af	
Harvey Creek	14.6	3 cfs 2,172 af	

[a]In addition, DFWP already has claimed rights on Rock Creek and the Blackfoot River.

[b]10 cfs is requested if diversions to Storm Lake do not occur at their usual level. If diversions are resumed at their past levels, the flow request is 3 cfs.

FIGURE 2-1

RESERVATION REQUESTS IN THE UPPER CLARK FORK BASIN



during the summer were lower than the standards set to protect aquatic life.

DFWP contends that a reservation will provide for enhanced populations of aquatic organisms if present EPA Superfund cleanup efforts are successful. DFWP believes that instream flows would preserve existing recreational uses and provide for increased recreational use if cleanup activities are successful.

The reservation process established by the legislature provides for legal protection of instream flows. In the past, DFWP has objected to DNRC issuing new water-use permits on the Clark Fork near Deer Lodge claiming that the new water diversions would further degrade the fishery in this reach of river. DNRC has ruled these objections invalid because DFWP lacks any rights to instream flows that would be adversely affected by granting the permits. Obtaining a water reservation would give DFWP legal standing to object to those new permits or changes in water rights that would jeopardize the instream resources. If it does not obtain its requested reservations, DFWP believes that aquatic habitat and recreational opportunities in the Clark Fork basin will continue to deteriorate. The rate of deterioration depends on the extent to which consumptive water use increases in the future. These issues are examined further in Chapters Three, Five, and Six.

Amount

In preparing its reservation application, DFWP requested instream flows based on two considerations. They are: (1) the amount of instream flow needed in riffle areas (shallow rapids) for the survival of aquatic organisms that are a major food source for fish; and (2) the need to dilute pollutants during low-flow periods in the winter. DFWP says that the requested instream flow levels also would provide recreational opportunities for boaters and protect the physical habitat for fish in areas outside of riffles. Though the precise relationships among groundwater, stream flows, and riparian vegetation have not been determined in the upper Clark Fork basin, DFWP feels that the requested stream flows will help protect the riparian vegetation.

DFWP is particularly concerned with maintaining flows to protect water quality. Pollution from Silver Bow Creek poses a major hazard to quality of water in the main stem of the upper Clark Fork. The creek contains high concentrations of metals from the time it was used to dispose of industrial waste, and also contains nutrients from Butte's municipal wastewater. Contaminated water from the creek is treated in the Warm Springs ponds and discharged into the Clark Fork main stem. During the winter, treatment to remove metals from Silver Bow Creek water is less effective than in the summer. From January 1 to April 30, instream flows are requested for tributary streams to dilute metal-contaminated waters on the main stem (Table 2-1).

Public Interest

If the Board grants the requested instream flow reservations, DFWP (1986b) claims the following public benefits will occur:

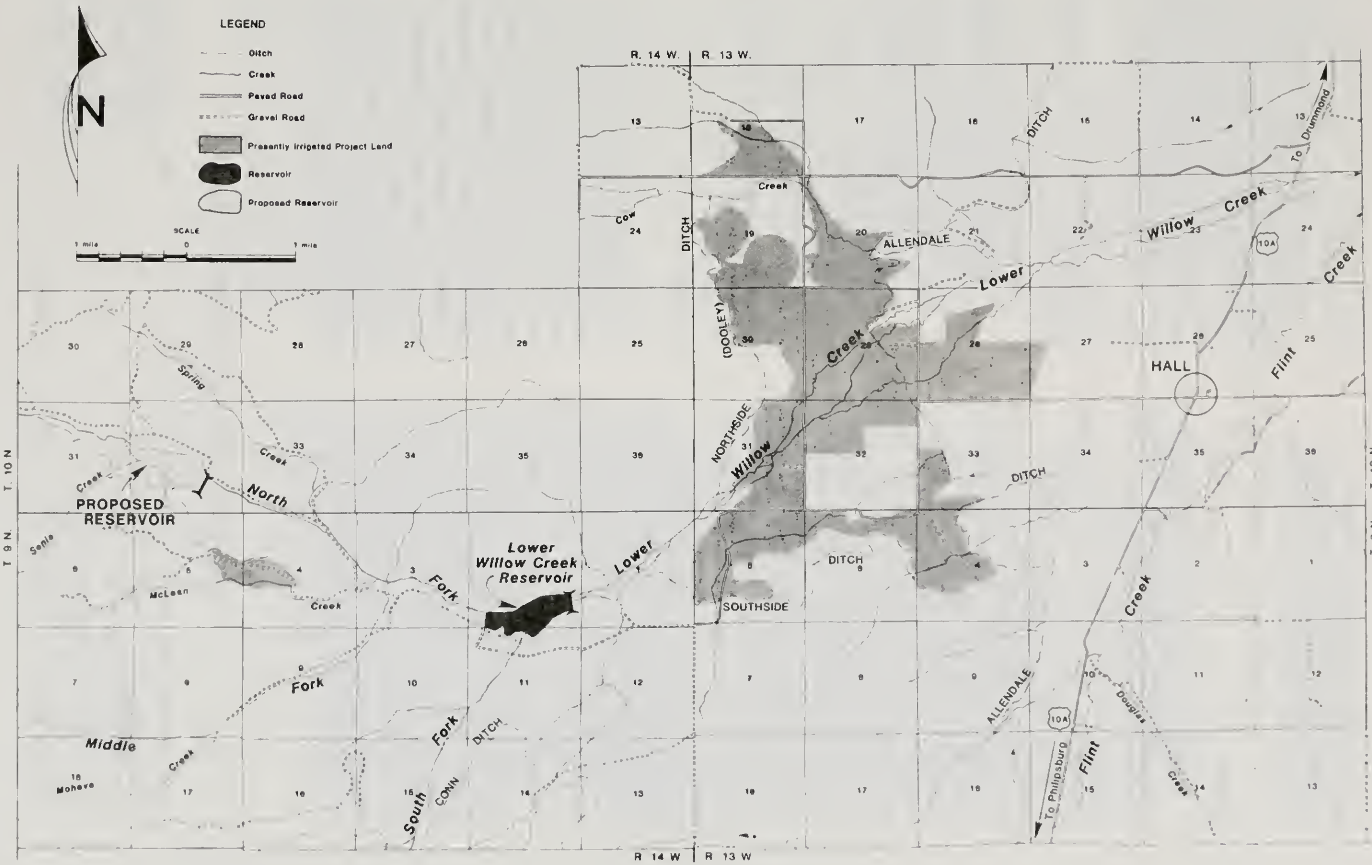
"1. continued perpetuation of the fish and wildlife resources whose very existence is in the public interest;
2. prevention of the gradual depletion of streamflows currently enjoyed by the public for recreational uses;
3. continued perpetuation of the fish and wildlife resources for current and future utilization by the public;
4. preservation of the opportunity for a substantially improved aquatic ecosystem;
5. maintenance of water quality which contributes to a clean, healthful environment for the citizens of the state and nation; and
6. contribution to the protection and continued utilization of existing water rights."

DNRC's analyses of these issues are presented in Chapters Five and Six.

GCD APPLICATION

The Granite Conservation District seeks a water reservation in the North Fork of Lower Willow Creek, a tributary of Flint Creek (Table 2-2). GCD initially requested an additional reservation on Boulder Creek,

FIGURE 2-2
LOWER WILLOW CREEK PROJECT AREA



but this request was withdrawn. The existing and proposed reservoirs, irrigated lands, and canal system are shown in Figure 2-2.

Purpose

The reservation on the North Fork of Lower Willow Creek would allow construction of a new dam to provide supplemental irrigation water for 2,900 acres of land now irrigated with water from the Lower Willow Creek Reservoir. In addition, during wet years excess storage could be used to provide supplemental water to 7,500 acres of land now served by the Allendale Irrigation Company, the Flint Creek Water Users Association, and private irrigators. The North Fork of Lower Willow Creek project would require a new 113-foot high, 1,070-foot long dam creating a reservoir with a storage capacity of 5,000 acre feet (4,950 af of active storage). GCD estimates that the proposed reservoir would make water available for the entire irrigation project 91 percent of the time during the irrigation season, compared to 58 percent of the time as at present. The reservoir would flood 112 acres. No new canals would be needed. Water from the new reservoir would be released into the North Fork of Lower Willow Creek, flow downstream, and refill the existing Lower Willow Creek Reservoir.

Granting a reservation to GCD would establish a priority date for the water to be used for the future irrigation storage project. If GCD obtains a reservation, its use of reserved flow could not be adversely affected by any new water-use permits issued after the reservation is granted. A reservation can only be granted if water is legally available for consumptive use.

Need

GCD is applying for a reservation to ensure water will be available for the proposed project on the North Fork of Lower Willow Creek. The applicant notes that the proposed project cannot be built under present economic conditions. When the economy becomes stronger, GCD would use the water that it seeks to reserve. If the reservation is not granted, unappropriated water may not be available for three reasons:

1. DNRC studies show that present appropriations use all the available water most of the year.
2. DFWP is seeking reservations on Flint Creek that, if granted, would not leave enough water available for the proposed project.
3. Any available water could be appropriated by another party before GCD builds the project.

DNRC's analysis of need for this project is presented in Chapter Six.

Amount

GCD requests a reservation of 11,165-acre feet but acknowledges that the amount needed for the new reservoir may be somewhat less than this. The 11,165-acre feet includes water already being used for the lands currently irrigated with water from Lower Willow Creek Reservoir (see Figure 2-2). At this time there is uncertainty if the amount of water applied for is available. This can be attributed to the fact that existing hydropower water rights held by Washington Water Power (WWP) for its generation facilities at Noxon Dam might severely limit the amount of water available

Table 2-2. GCD's Reservation Request.

Stream Name	Flows and Volume of Water Requested
North Fork of Lower Willow Creek	up to 15.4 cfs up to 11,165 af

upstream. The Montana Power Company (MPC) also holds sizable water right claims for its hydroelectric plants at Thompson Falls and Milltown. Historically, hydropower rights have not precluded the issuance of new permits, but they might in the future. GCD lists four strategies to overcome constraints to water availability that might be posed by the water right claims and permits of downstream hydroelectric facilities.

1. Have the proposed North Fork of Lower Willow Creek project sponsored or funded by the federal government in order to subordinate downstream hydropower rights. The federal licenses for the downstream hydroelectric projects already contain certain conditions which allow for their subordination to future upstream federal water resource development;

2. Negotiate an exchange of water rights among WWP, MPC, and the Bureau of Reclamation (as discussed in Chapter Five). Hungry Horse Reservoir is a Bureau of Reclamation project that was established for multiple purposes which include irrigation;

3. Attempt to subordinate the WWP and MPC projects to future upstream developments by inclusion of such terms in the licenses for these projects, when they come up for relicensing by the Federal Energy Regulatory Commission (FERC). MPC has asked FERC to extend its license at Milltown to the year 2015. The current license will expire in 1993. The license for Thompson Falls expires in 2015. FERC may also consider GCD's request for subordination at the time of construction (FERC 1988). Relicensing of WWP's Noxon Rapids Dam is not scheduled until the year 2005.

4. Subordinate hydropower uses to upstream developments via state legislation. It would require an amendment to the Federal Power Act to give the state this authority.

GCD is optimistic that one of these strategies will ensure water availability in the Clark Fork basin. DNRC's analysis of these strategies is presented in Chapter Five.

<u>Public Interest</u>

To fulfill the requirement that the reservation must be in the public interest, GCD estimated project costs and benefits and briefly discussed unquantified costs and benefits. GCD estimates that the direct benefits to project water users would be 1.8 times the cost of the project. GCD also expects that the project will receive state and federal assistance from several sources and estimates that benefits would then be 4.4 times GCD's share of project costs. According to GCD, the project would provide indirect benefits by increasing spending in the local economy.

Unquantified project costs considered by GCD would include decreased fisheries below the proposed reservoir, decreased dilution of pollutants in the Clark Fork, inundation of wildlife habitat, decreases in water quality, decreased air quality during construction, and decreased aesthetic quality. According to GCD, the unquantified benefits are that fishing should improve at the existing Lower Willow Creek Reservoir, stream flows would be maintained during low-flow periods, streambed erosion would be reduced during high flows, and erosion would decrease on project lands. GCD claims the benefits of the project outweigh its costs. DNRC's analysis of costs and benefits is presented in Chapter Six.

CHAPTER THREE

WATER RESOURCES AND AVAILABILITY

One of the primary purposes of this EIS is to determine how GCD's and DFWP's requests for reservations would affect water availability in the Clark Fork basin. This chapter describes how much water is physically available for existing water rights and additional uses in the Clark Fork and its major tributaries, and presents a discussion of legal water availability and the uncertainties associated with legal water availability.

Near the Montana-Idaho border, the Clark Fork has an average annual flow rate of 21,020 cfs, making it Montana's largest stream (USGS 1987). The availability of water in the basin is governed by an interplay of natural and legal factors. On a yearly basis, natural factors such as the amount of snowmelt or the frequency of rainfall can vary widely and unpredictably. Legal factors--the complex array of water rights that govern water use--also change from year to year with the issuance of new permits and changes in existing rights. The interaction of these natural and legal factors gives rise to uncertainties over the availability of water in the Clark Fork basin for future needs. In particular, there is a question as to whether or not existing water rights would limit the amount of water available to future water users. The water rights in question are those associated with the large hydropower plants in the basin and with irrigators throughout the upper basin.

There are several reasons for the uncertainty over whether existing water rights would or would not constrain water availability. One reason is that the water court has not yet issued a final decree concerning water right claims in the Clark Fork basin, and the state is still in the adjudicating process. At present, claims in the Clark Fork basin, as filed, must be considered as valid, but the amount of water claimed may be changed during the final adjudication. If the amount of water decreed in the adjudication process is less than the amount claimed, there may be more unappropriated water available for future use than currently projected.

Another cause for uncertainty stems from the water right holders themselves. If the proposed new uses would adversely affect existing water rights, senior holders may choose to object to the application, but no one can be required to object. For example, DNRC initiated discussions with WWP to determine the effect of issuing new consumptive use permits on WWP's hydropower uses and to establish the likelihood of WWP objecting to new permits. To date, WWP has not objected to the issuance of new permits in the basin.

It is also possible for water rights to be sold for other upstream uses, but only if the purchaser can demonstrate that the new use would not adversely affect other water right holders. For example, if a downstream hydropower producer were willing to sell a portion of its water rights and FERC approves the decision, it is possible that the rights could be purchased for new consumptive development in the upper basin.

An additional cause of uncertainty in the basin is the presence of unquantified federal reserved water rights. Claims have

been made in the basin by the United States Department of Agriculture for water rights for the national forests. Also, on behalf of the Confederated Salish and Kootenai Tribes of the Flathead Reservation, the Bureau of Indian Affairs has filed a claim in the Clark Fork Basin for instream flows to protect aboriginal rights recognized by treaty. The nature and extent of water rights for these purposes will be determined within the state adjudication, either through negotiations with the Montana Reserved Water Rights Compact Commission or through the Water Court.

Uncertainty over legal water availability also arises from GCD's four strategies to overcome possible hydropower constraints, as listed in the previous chapter. The success of any one of these strategies relies upon inherently unforeseeable actions.

Because of the uncertainties described above, two possible scenarios affecting water availability are addressed in each of the environmental, economic, and social analyses in this EIS. In the first scenario, existing downstream water rights would constrain development, effectively limiting water availability for new consumptive uses. Changes of existing water uses would still be possible where these changes did not adversely affect other uses in the basin. In the second scenario, existing water rights would not limit additional consumptive use. Water would be available in spite of existing water rights, and new development could occur. Each of these scenarios would produce different results and impacts, and the reader should bear in mind which scenario is being presumed for any particular analysis.

PHYSICAL WATER AVAILABILITY

Figures 3 through 10 in Appendix B summarize how much water is present in various reaches of the Clark Fork. These figures depict levels of flow that are equaled or exceeded in 2, 5, and 8 years out of 10. In June, the Clark Fork's flow at Deer Lodge (Figure B-4) is at least 897 cfs 20 percent of the time, or 2 years out of 10. On the other hand, the smaller flow of 297 cfs is equaled or exceeded 80 percent of the time, or 8 years out of 10, in June.

It is apparent from Figures 3 through 10 that the highest flows take place during spring runoff and the lowest occur in the winter months or late summer. In summer, irrigation diversions dramatically reduce flows in tributaries and the main stem. In the Deer Lodge area, irrigation withdrawal nearly depletes the river during dry years (see tables in Appendix B).

Warm Springs Creek experiences very low flows; sometimes the stream is almost completely depleted in its lower reach during the summer months. This is due to a diversion at Meyers Dam and an irrigation diversion 2 1/2 miles below Anaconda (Montana DFWP 1986b).

Figures 11 through 14 in Appendix B summarize water availability on tributary streams where complete monthly flow records exist. Not all tributary streams in the upper basin have U.S. Geological Survey stream gauges. On several of these streams, the Anaconda Company formerly operated stream gauges at least during part of the year. Data for tributary streams with partial records are presented in Table 3-1.

LEGAL WATER AVAILABILITY

To date, DNRC continues to issue new water use permits in the upper Clark Fork basin. Historically, water right holders have not systematically objected to new applications or petitioned DNRC to close the basin to further appropriations. DFWP has objected to permit applications, but DNRC has rejected these objections on the grounds that DFWP does not have legal standing to object. If DFWP is granted an instream reservation, it will gain that legal standing. New appropriations may be prevented if downstream users were to object and could demonstrate that they would be adversely affected by the new water uses.

Existing water appropriations might limit future consumptive water uses in the upper Clark Fork. Figure 3-1 shows the water rights greater than 100 gallons per minute claimed in the Clark Fork basin prior to 1973. The claims add up to more than the

Table 3-1. Average monthly flows for gauged streams with partial flow records. The first number is the average flow in cfs; the number in brackets is the number of years records exist.

Drainage	Oct	Not	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
North Fork	5.4 cfs	7.9	---	---	---	---	---	37.1	54.3	21.8	7.3	5.5
Flint Cr	(9 yrs)	(1)	(0)	(0)	(0)	(0)	(0)	(8)	(13)	(14)	(14)	(14)
Twin Lakes	8.3 cfs	---	---	---	---	---	---	59.1	116.5	62.0	20.8	21.5
Creek	(1 yr)	(0)	(0)	(0)	(0)	(0)	(0)	(4)	(10)	(13)	(13)	(13)
Stuart Mill	---	---	---	---	---	---	---	10.7	19.5	18.7	13.7	11.4
Creek	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(11)	(11)	(11)	(11)	(11)

Source: USDA 1987b.

total annual flow of some streams because the amount of water claimed indicates only the amount that is diverted. Not all diverted water is consumed, however. In the case of hydropower diversion, nearly all the water is returned to the stream. In agricultural use, a portion of the water is consumed, but the remainder returns to the stream and is available for reuse downstream. In addition, not all consumptive uses occur at the same time because some water uses are seasonal.

Figures 3-2 through 3-4 show how much water has been allocated by water use permits issued since 1973. These figures depict permits greater than 100 gpm and show that since 1973, irrigation and hydropower production have been the two largest new water uses in the basin.

The major hydropower water rights along the Clark Fork and upper basin tributaries are listed in Table 3-2, and locations of the dams are shown in Figure 3-5. Each of the major hydropower projects is discussed in more detail later in this chapter. Hydropower water rights might be the greatest potential limitation to future upstream consumptive use.

When water right claims and permits held by WWP, the largest single appropriator in the basin, are considered, flows in excess of 50,000 cfs are available for future use by others. When flows are less than 50,000 cfs at Noxon Rapids Dam, water may or may not be available for appropriation. Flow

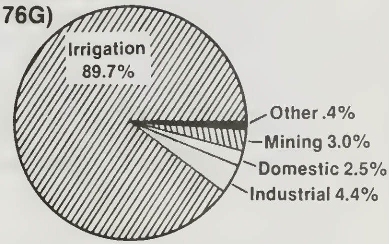
Table 3-2. Major hydropower water rights in the Clark Fork basin.

	Pre-1973 Claims cfs	Post-1973 Permits cfs	Total cfs
Washington Water Power Company			
Noxon Rapids Dam	40,400	9,600	50,000
Montana Power Company			
Milltown Dam	2,000	--	2,000
Thompson Falls Dam	11,120	--	11,120
Flint Creek (Georgetown Lake)	30	--	30

Source: Montana DNRC 1987.

Figure 3-1. Pre 1973 Claimed Rights Greater than 100 GPM

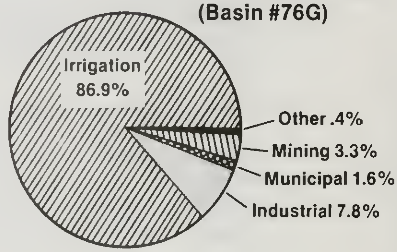
Clark Fork Basin Above Blackfoot River (Basin #76G)



10,191 cfs claimed

CFS

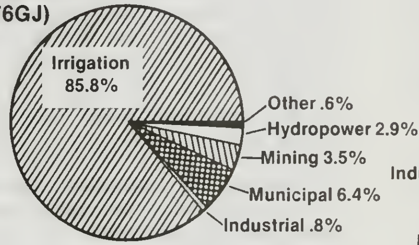
Clark Fork Basin Above Blackfoot River (Basin #76G)



2,309,452.17 acre-feet claimed

Acre-feet

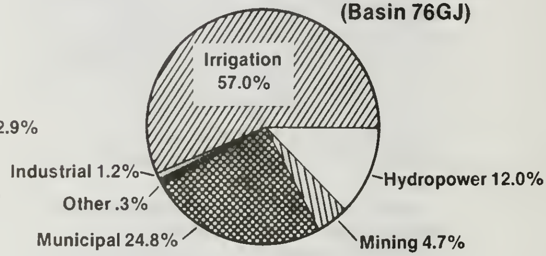
Flint Creek Basin (Basin #76GJ)



2,847 cfs claimed

CFS

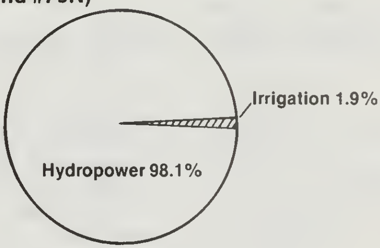
Flint Creek Basin (Basin 76GJ)



506,033 acre-feet claimed

Acre-feet

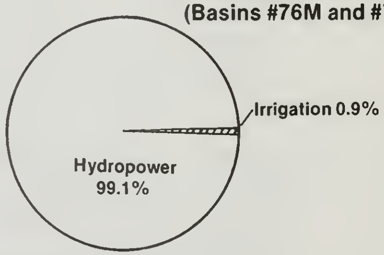
Clark Fork Main Stem Milltown Dam to Montana-Idaho Border (Basins #76M and #76N)



62,263 cfs claimed

CFS

Clark Fork Main Stem Milltown Dam to Montana-Idaho Border (Basins #76M and #76N)



23,614,408 acre-feet claimed

Acre-feet

76G includes all tributaries except Rock Creek and Flint Creek.
76GJ includes Flint Creek and all tributaries.
76M and 76N includes the Clark Fork Main Stem and all minor tributaries.

Figure 3-2. Post 1973
Pending and Permitted Rights
Greater Than 100 GPM in the
Upper Clark Fork Basin (76G)

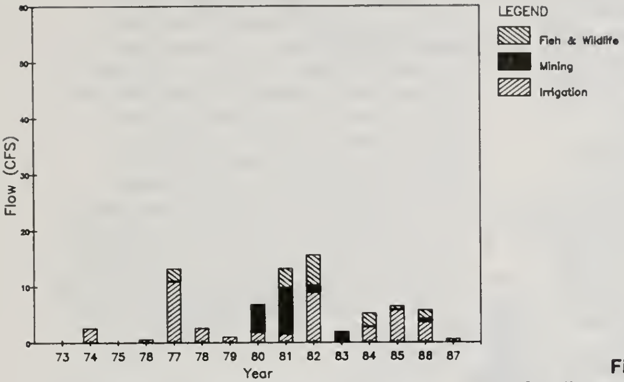


Figure 3-3.
Pending and Permitted Rights
Greater Than 100 GPM in the
Flint Creek Basin

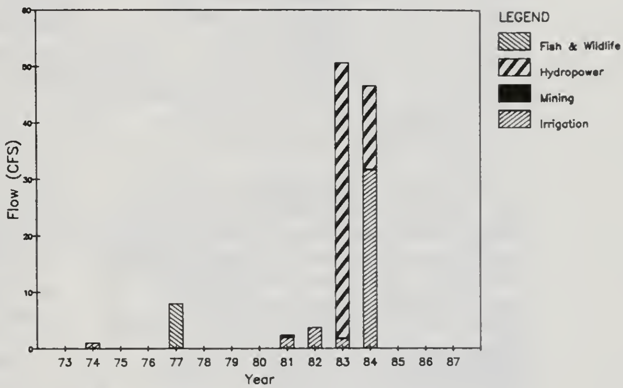
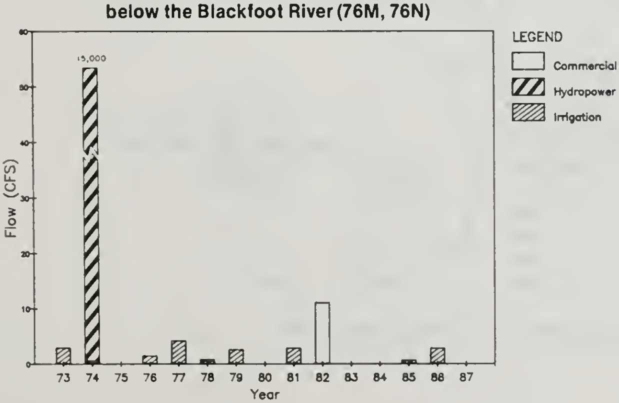


Figure 3-4.
Pending and Permitted Rights
Greater Than 100 GPM in the Lower Clark Fork
below the Blackfoot River (76M, 76N)



records at Noxon Rapids Dam for the period from 1961 to 1986 indicate that, on the average, flow exceeds 50,000 cfs during 22 consecutive days per year. The number varies from 0 to 65 days per year depending on annual precipitation and snowpack. The frequency of years with flows above 50,000 cfs is certainly no more than 5 years in 10, and is more likely 3 or 4 years in 10 (Holnbeck 1987). Physically, water may be present in the Clark Fork main stem or tributaries in the upper basin, but WWP has legal rights and claims to that water at Noxon Rapids Dam. Besides the WWP water rights, MPC claims a right of 2,000 cfs for its power facility at Milltown Dam. MPC's water right claim at Milltown Dam has a priority date of 1904. On an average monthly basis, flows in excess of 2,000 cfs are available at Milltown only during 4 months--April through July. In periods of relatively high flows, 2 years out of 10, water in excess of 2,000 cfs is available for 7 months. Historically, hydropower producers have not acted to constrain consumptive development in the upper basin, and DNRC has issued consumptive use permits in the upper Clark Fork basin.

Along with the large hydropower water rights, other existing water rights in the basin might limit the water available for future consumptive uses. The validity of these claims is being determined in the statewide adjudication process. New consumptive use permits could continue to be issued after existing claims have been adjudicated as long as the existing uses are not adversely affected.

HYDROPOWER REQUIREMENTS

Montana's Clark Fork basin supplies water for seven hydroelectric facilities with individual generation capacities of one megawatt or greater. Two of the facilities, Montana Power Company's Flint Creek Dam on Flint Creek at Georgetown Lake and Milltown Dam on the Clark Fork are located in the upper Clark Fork basin. MPC's Thompson Falls Dam and WWP's Noxon Rapids Dam are located downstream on the Clark Fork, though their operations are influenced by flows from the upper basin (Table 3-3). The other three facilities, which are not listed, are located in the Flathead River drainage, a tributary to the Clark Fork.

MPC is the largest producer and marketer of electricity in Montana. Electricity rates for MPC customers are considerably lower than national norms, primarily because of lower costs attributable to hydropower generation.

All three of Montana Power's hydroelectric facilities are generally operated as "run of the river" generating units. These dams have little storage and the flows through the turbines at any given time are approximately equal to the natural flow in the river. The generators operate at or near their capacities only during spring runoff.

MPC has proposed to increase the generation capabilities of the Milltown Dam to 4.4 MW. The company also is attempting to sell its Flint Creek Dam, which is in need of renovation.

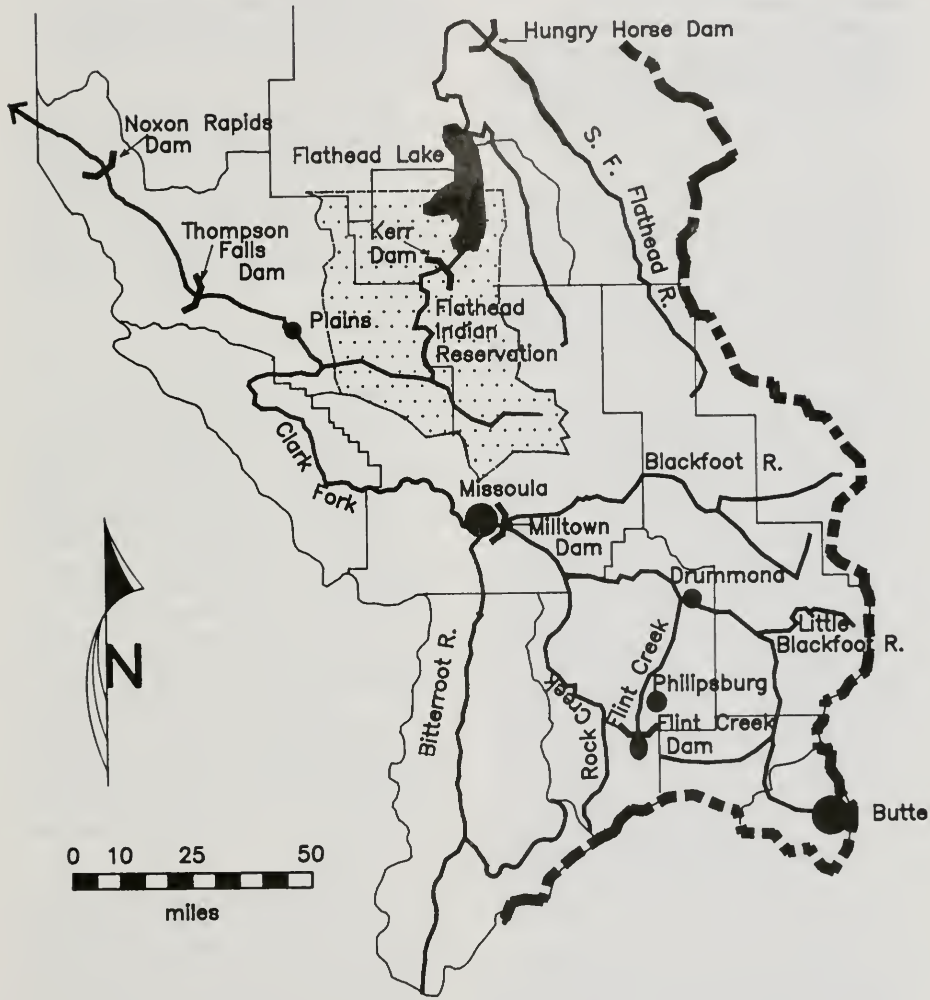
Table 3-3. Hydroelectric dams, Clark Fork basin.

	Owner/ Operator	Capacity (megawatts)	Hydroelectric Production in Normal (median) Water Year (megawatts)
Flint Creek	MPC	1.1	1.0
Milltown	MPC	3.2	2.0
Thompson Falls	MPC	40.0	34.0
Noxon Rapids	WWP	554.0	203.6

Sources: Montana Power Company 1983, Steele 1984, Woodworth 1987.

FIGURE 3-5

LOCATION OF HYDROPOWER FACILITIES
IN THE CLARK FORK BASIN



The Noxon Rapids Dam is owned and operated by WWP, a Spokane-based, investor-owned utility serving northern Idaho and eastern Washington. With a peak production capability of 554 megawatts, the Noxon Rapids Dam is the second largest hydroelectric generating facility in Montana.

Noxon Rapids Dam is operated as a combination "run of the river" and "peaking" facility. Generally, the amount of electricity produced by the facility is determined by flows in the Clark Fork. By timing the releases of stored water, WWP is able to produce additional electricity during periods of peak demand. A voluntary agreement between WWP and DFWP limits daily drawdown to 10 feet below the maximum reservoir level, thus limiting the peaking capabilities of the facility (Woodworth 1987).

The Noxon Rapids Dam requires the 50,000 cfs of flow to operate at full generation capacity. This flow only occurs during spring runoff. The system's production for a median water year is 37 percent of what it would produce if 50,000 cfs were available all year (Young 1987).

CHAPTER FOUR

EXISTING ENVIRONMENT

This chapter describes the environmental resources of the Clark Fork that could be affected by the proposed reservations. This description focuses on the upper basin, but also describes resources that could be affected along the Clark Fork below the reaches where reservations are requested--primarily in the Missoula and Frenchtown areas.

EARTH RESOURCES

The portion of the Clark Fork most directly affected by the requested water reservations is located upstream from Milltown Dam (Figure 2-1). In this EIS, the region is referred to as the "upper basin." Headwater streams originate in the Flint Creek Range, Pintler Mountains, Garnet Range, Sapphire Mountains, and along the Continental Divide. Major tributaries of the upper basin include Warm Springs Creek, Silver Bow Creek, the Little Blackfoot River, Flint Creek, and Rock Creek. Major tributaries in the lower and middle portions of the basin include the Blackfoot, Bitterroot, St. Regis, and Flathead rivers. In Montana, the Clark Fork basin encompasses 22,000 square miles. The Clark Fork drains west into Idaho, where it flows into Lake Pend Oreille.

Most of the surface material in the valleys of the upper Clark Fork basin consists of sediments eroded from the surrounding mountains. The gently sloping-to-rolling terrain in the valleys is cut by the present-day channels of the Clark Fork and tributary streams. Soils in the alluvial valleys and sedimentary benchlands are generally suitable for farming except for areas contaminated by mining and smelting wastes or where the terrain is too steep.

Most cultivated lands in the upper basin have soil textures ranging from loams to gravelly loams. Cultivated land generally is located on nearly level to moderately sloping lands in the valleys or on adjacent upland benches. Irrigated lands are mostly along the valley floors where canals bring water from the Clark Fork or a tributary stream.

Some of the land adjacent to the Clark Fork has been contaminated with mine and smelting tailings and contains high concentrations of metals. Tailings from Butte and Anaconda have been transported by Silver Bow and Warm Springs creeks and deposited along the Clark Fork floodplain. Subsequent erosion and redistribution of these wastes resulted in the deposition of copper, arsenic, and cadmium on the Clark Fork floodplain. A study by Rice and Ray (1985) showed that soils in the floodplain between Rocker and Drummond contained elevated levels of copper, arsenic, and cadmium. Some heavily contaminated areas known as "slickens" are generally devoid of vegetation and, in some cases, can be identified by a blue-green crust of copper sulfate on the soil surface. This contamination limits the agricultural potential of floodplain soils as far downstream as Drummond (Elliott 1986).

Johns and Moore (1985) examined sediments of reservoirs along the length of the Clark Fork. They found sediments in Milltown Reservoir at Bonner had very high

concentrations of metals. Levels of metals in sediments at Thompson Falls, Noxon, and Cabinet Gorge reservoirs were much lower but these sediments still had concentrations slightly elevated above natural levels.

Irrigable Lands

Lands considered irrigable have soil, topographic, and climatic characteristics suitable for sustained crop production, and they are situated so that water can be economically diverted to them from a stream. Elliott (1986) used the Soil Conservation Service (SCS) soil survey data for Granite and Powell counties to identify irrigable land. Land that could be economically sprinkler irrigated was identified on the basis of elevation and distance from a stream. Land contaminated with metal-laden tailings along the Clark Fork and Warm Springs Creek was not considered irrigable.

Elliott's analysis revealed that, depending on the economic assumptions used, between 6,700 and 15,750 additional acres along the Clark Fork and major tributaries could be profitably irrigated. An additional 9,242 acres of potentially irrigable land was identified along smaller tributaries of Flint Creek and the Little Blackfoot River. DNRC subsequently evaluated the lands identified by Elliot and found that water was not available throughout much of the irrigation season on many of the tributary streams. Consequently, Elliott's estimates of irrigable land were reduced to 8,362 acres along the Clark Fork and tributaries to correspond to water availability. These reduced acreages were used throughout the rest of DNRC's analysis. Table 6 in Appendix D lists irrigable land by drainage basin.

LAND USE

The upper Clark Fork basin has experienced intensive human use for the past 100 years. Agriculture, transportation, water developments, and mining have had the greatest influence on the basin's land use. The mines in western Montana were also the impetus behind the upper basin's early development as an agricultural center.

Agriculture

Agriculture, primarily livestock production, dominates land use in the upper basin. From 1980 to 1985, livestock contributed approximately 85 percent of the total agricultural revenue in Deer Lodge, Granite, and Powell counties. Most crop production is used as livestock feed (Montana Department of Agriculture 1986).

The basin's mountainous forested tracts are interspersed with rangeland and cultivated areas on the terraces and floodplains of the valley bottoms. The forested areas at higher elevations are mostly public land administered by the U.S. Forest Service. The Deerlodge National Forest includes 1.3 million acres, of which about 200,000 acres are private inholdings or public lands administered by the State of Montana or the Bureau of Land Management. Timber productivity on the Deerlodge National Forest ranges from less than 20 to about 49 cubic feet/acre/year. The Forest Service also leases out about 67,000 animal unit months (AUMs) of livestock grazing per year (USDA 1987a). The Lolo National Forest encompasses about 2 million acres of land, including about 146,000 acres in 4 wilderness areas. Timber productivity ranges from less than 20 to over 100 cubic feet/acre/year. The Lolo National Forest provided about 11,000 AUMs of livestock grazing in 1985 and proposes providing about 14,000 AUMs per year through 2030 (USDA 1986).

The floodplains and terraces of the Clark Fork and its tributaries support dryland pasture, irrigated pasture, and crops. Approximately 82,000 acres have been developed for irrigation in the upper Clark Fork basin (Elliott 1986). Over the past 16 years, 86 percent of the cropland in the three counties of the upper basin has been irrigated. The major crops grown are grass hay, alfalfa, and small grains such as barley and spring wheat. Both flood irrigation and sprinklers are used extensively. Very little land is irrigated by pumping directly from the Clark Fork. Most irrigated terraces or benches receive water from tributary drainages that have been diverted at higher elevations (Elliott 1986). Table 7 in

Appendix D contains a list of irrigated acreage along the upper Clark Fork and its tributaries.

The productivity of these lands varies greatly. Rangeland along the valley bottoms and terraces produces a maximum of 0.25 AUMs per acre. Alfalfa hay on moist floodplain soils yields an average of 2.0 tons per acre and also provides approximately 1.0 AUM/acre of grazing. Alfalfa under full service irrigation yields an additional 1.0 AUM per acre and an average of about 2.5 tons per acre over the life of a stand (Dodds 1988). Irrigated small grain crops such as barley yield 60-80 bushels per acre (Montana Department of Agriculture 1986). Some floodplain soils between Anaconda and Drummond are considerably less productive because of heavy metal contamination.

GCD's proposed new reservoir would cover pasture land that is now irrigated by a spreader ditch system. The reservoir would be used to supply supplemental water for 2,900 acres now being irrigated with water from the existing lower Willow Creek Reservoir. These lands support irrigated crops, including alfalfa, mixed hay, small grains, and pasture. Over the last 24 years, Lower Willow Creek Reservoir has been able to provide irrigation water to project land and satisfy 58 percent of the demand (GCD 1987).

Transportation and Population Centers

A major transportation corridor follows the upper Clark Fork for its entire length. The construction of Interstate 90 required the rechannelization of certain reaches. Meanders were severed from the river and extensive rock riprap was installed. Two artificial meanders were built between Garrison and Jens to compensate for the effects of eight separate channel changes and the resulting artificial increase in stream gradient. Construction of the Northern Pacific Railroad severed a large meander from the Clark Fork above Rock Creek. This rail line is now leased from Burlington Northern by Montana Railink (Interstate Commerce Commission 1988).

The largest communities in the upper Clark Fork basin are Butte, Anaconda, and Deer Lodge. Smaller communities include Bonner, Clinton, Drummond, Philipsburg, Garrison, and Avon. All urban and town areas lie adjacent to the Clark Fork or one of its tributaries. These municipalities rely on both surface and groundwater for public water supplies. Rural subdivision has occurred along many of the roads and highways that follow the main stem Clark Fork or its tributaries.

Water Developments

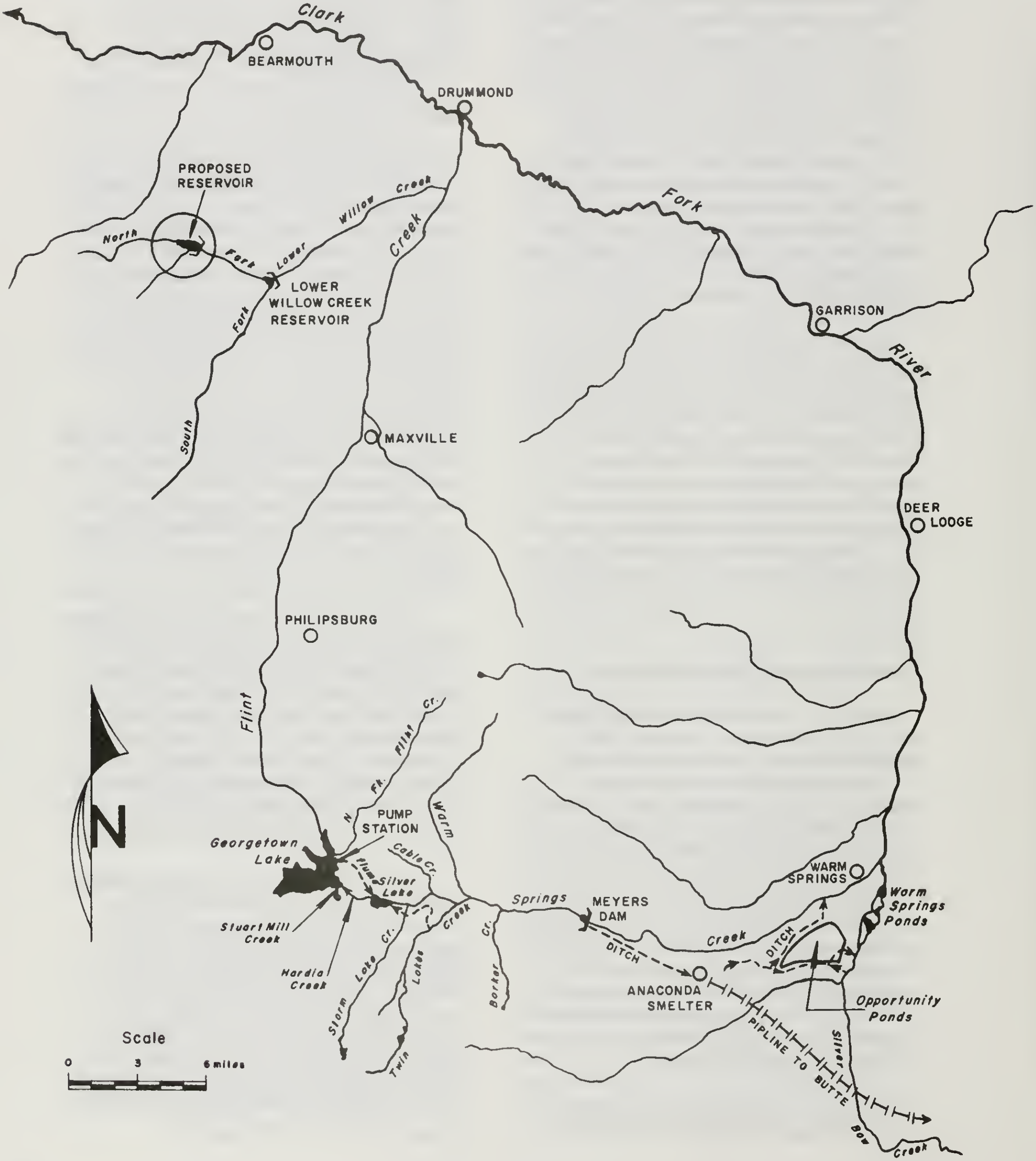
Within the Flint Creek and Warm Springs Creek basins, a system of pipelines, canals, pumping stations, and reservoirs was built to provide water for the Anaconda Company's mining and smelting activities (Figure 4-1). The system consists of diversions from Twin Lakes Creek and Storm Lake Creek into a reservoir called Silver Lake near the Warm Springs-Flint Creek Divide. As Silver Lake was filled, excess water would flow via canal into Georgetown Lake. When water was needed in Anaconda and Butte, water was pumped from Georgetown Lake back into Silver Lake and from Silver Lake into the head of Warm Springs Creek. The water would flow down Warm Springs Creek to Myers Dam where it was diverted and piped to the company's facilities in Anaconda and Butte.

Montana Resources Incorporated (MRI), which now owns the Anaconda properties, has been issued a preliminary water rights decree of no more than 56,000 acre-feet of water from the Silver Lake system. The system has not been operated in the last several years. The Granite County Commissioners, landowners along Flint Creek, and the Butte Water Company have expressed interest in buying the rights to this water.

In addition to the old Anaconda system of pipelines and storage facilities, several other dams and canals were constructed over the years to ensure adequate water supply for irrigation in the Flint Creek drainage. The most extensive system for supplying irrigation water consists of a reservoir on Rock Creek, a Clark Fork tributary located west of Flint Creek, and a canal that brings water from this reservoir over the Rock Creek-Flint Creek divide to irrigated land west of Philipsburg.

FIGURE 4-1

WATER WORKS IN THE FLINT CREEK DRAINAGES



A second irrigation storage reservoir is operated by the Lower Willow Creek Drainage District on Lower Willow Creek southwest of Drummond. The reservoir has a storage capacity of 5,000 acre-feet of water, and approximately 2,900 acres are irrigated with water from this project. The Allendale Canal (known locally as the State Ditch) takes water from Flint Creek to irrigate land on the west side of the Flint Creek valley between Maxville and Drummond. The canal also intersects Lower Willow Creek below the reservoir. Water rights for the Allendale Canal have an earlier priority date than water rights for the reservoir.

Mining

The upper Clark Fork basin contains extensive mineral deposits. The best known are the ore bodies near Butte which have been mined for copper, silver, and other metals. Lesser known areas include several mines in the Flint Creek Range near Princeton, Philipsburg, and Anaconda, and mines in the Garnet Range south of Garnet. A variety of metals have been mined, including gold, silver, manganese, zinc, lead, and copper. Gold-bearing gravels have been worked at the mouth of Bear Gulch, in Gold Creek, and other points in the upper basin.

The Phosphoria Formation, a sedimentary deposit containing the mineral phosphate, is found along the northern and northeastern flanks of the Flint Creek Range and in the Garnet Range north of the Clark Fork. An active phosphate mine near Garrison taps the Phosphoria Formation.

WATER QUALITY

Water in parts of the upper Clark Fork basin has been degraded by wastes from past mining activities, agricultural practices, and human habitation. Mining and smelting have contributed metals such as copper and zinc in concentrations high enough to be toxic to fish. Local agricultural activities contributed sediment and nutrients. Nutrients also have been added to the river system from treated municipal wastewater. Water quality on the tributary streams, although degraded in some stretches, is generally good compared to that of the Clark Fork main stem.

Water quality classifications in the upper Clark Fork drainage range from the best (A1) to the worst (E) under the DHES water quality classification system (ARM 16.20.604-624). Table 4-1 shows the water quality classifications for streams in the drainage, and Table 4-2 summarizes the standards for each classification.

The water quality criteria generally reflect existing conditions in the drainage. Stream reaches classified as A-1 reflect high water quality in that reach and are afforded the highest level of protection from future degradation. Silver Bow Creek, on the other hand, is an EPA "Superfund" hazardous waste cleanup site and is listed as a Class E stream. However, even in Silver Bow Creek fish have recently been found where none had been detected in the past, and some officials are considering the possibility of upgrading the classification of Silver Bow Creek. Silver Bow Creek carries high levels of dissolved copper, cadmium, zinc, and iron into the Clark Fork. The Silver Bow Creek "Superfund" site was recently extended downstream to include the Clark Fork from its headwaters to Milltown.

Metal Contamination

Mine tailings containing copper and other metals have been dumped near stream

Table 4-1. Water quality classifications in the upper Clark Fork drainage.

Clark Fork drainage except waters listed below	B-1
Warm Springs drainage above Myers Dam	A-1
Clark Fork from Warm Springs Creek to Cottonwood Creek (near Deer Lodge)	C-2
Clark Fork from Cottonwood Creek to the Little Blackfoot River	C-1
Georgetown Lake and its tributaries	A-1
Silver Bow Creek	E

Table 4-2. Summary of Montana water quality standards.

A-1 Waters are suitable for drinking, culinary, and food processing purposes after conventional treatment. Water quality must be suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and aquatic life, waterfowl and furbearers. This classification allows no increases in turbidity and color above naturally occurring levels without a permit from the Department of Health and Environmental Sciences (DHES).

B-1 Waters are suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Slight increases in turbidity and color are allowed without a permit. Dissolved oxygen concentration must not be decreased below 7.0 mg/l.

C-1 Waters are suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Larger increases in turbidity are allowed than under the B-1 classification. Dissolved oxygen concentration must not be reduced below 7.0 mg/l. Larger increases in water temperature are allowed than in the A-1 and B-1 classifications. Along the Clark Fork higher limits have been set for metals than in the other classifications.

Maximum Instantaneous Metal Concentration Allowed for Class C-1

	mg/l
Total Copper	90
Total Zinc	300
Total Iron	1300
Total Lead	100
Total Cadmium	10
Total Arsenic	50
Total Mercury	1

C-2 Waters are suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Dissolved oxygen concentration must not be reduced below 7.0 mg/l from October 1 through June 1 and below 6.0 mg/l from June 2 through September 30. The metals limits are:

Maximum Instantaneous Metal Concentrations Allowed for Class C-2

	mg/l
Total Copper	90
Total Zinc	300
Total Iron	2200
Total Lead	100
Total Cadmium	10
Total Arsenic	50
Total Mercury	1

E Water classified "E" is suitable for agricultural and industrial water uses other than food processing. This classification allows water to be degraded to the point where it is not suitable for trout or other salmonids. Dissolved oxygen concentration must not be lowered below 3.0 mg/l.

channels in the Butte and Anaconda areas. Tailings containing these metals have washed down Silver Bow and Warm Springs creeks and have been deposited in streambanks and sediments along the Clark Fork at least as far downstream as Bonner.

Beginning in 1911, the Anaconda Copper Mining Company constructed several dams creating a series of settling ponds on Silver Bow Creek just above its confluence with Warm Springs Creek. These were intended to remove copper and other metals (Tuesday and others 1987). Lime was added to the ponds to raise the pH in the water so metals would precipitate and settle to the bottom of the ponds. The early treatment ponds were not completely effective because the quantity of metals entering the ponds was simply too large to be removed through liming (Phillips 1985). In the 1970s, additional treatment facilities were built on Silver Bow Creek and the ponds are now better able to remove the metal load. The treatment pond system works well except during the winter and during periods of high flow. During winter months, water discharged to the river still contains somewhat elevated copper levels. It is not known why the ponds are less effective in the winter.

During periods of high flow, the settling ponds cannot handle the entire flow of Silver Bow Creek. To prevent the dams from washing away during high flows, a bypass canal known as the Mill-Willow bypass has been built. The diversion is designed so that flows greater than about 600 cfs are diverted around the settling ponds. In practical terms, the pond inlet often becomes plugged with debris and flows above 300 cfs may be diverted around the ponds. The water diverted around the ponds contains high levels of copper that can be toxic to fish. State and federal officials and representatives of industry and conservation groups are examining options for treating water from the bypass canal.

Even though most metals are now being removed from Silver Bow Creek, metals deposited in the floodplain along the Clark Fork before construction of the settling ponds continue to cause problems. The magnitude of this problem is just beginning to be well understood. Data provided by the Department of Fish, Wildlife and Parks (Montana DFWP 1986b) show that in the first part of June 1984, flows and metals concentrations increased with distance downstream to the confluence with Rock Creek (Figure 4-2).

Data presented by DFWP indicate that metals also are found in the floodplain of Warm Springs Creek. These studies show that spring runoff in 1983 and 1984 caused copper concentrations to increase in Warm Springs Creek (Montana DFWP 1986b).

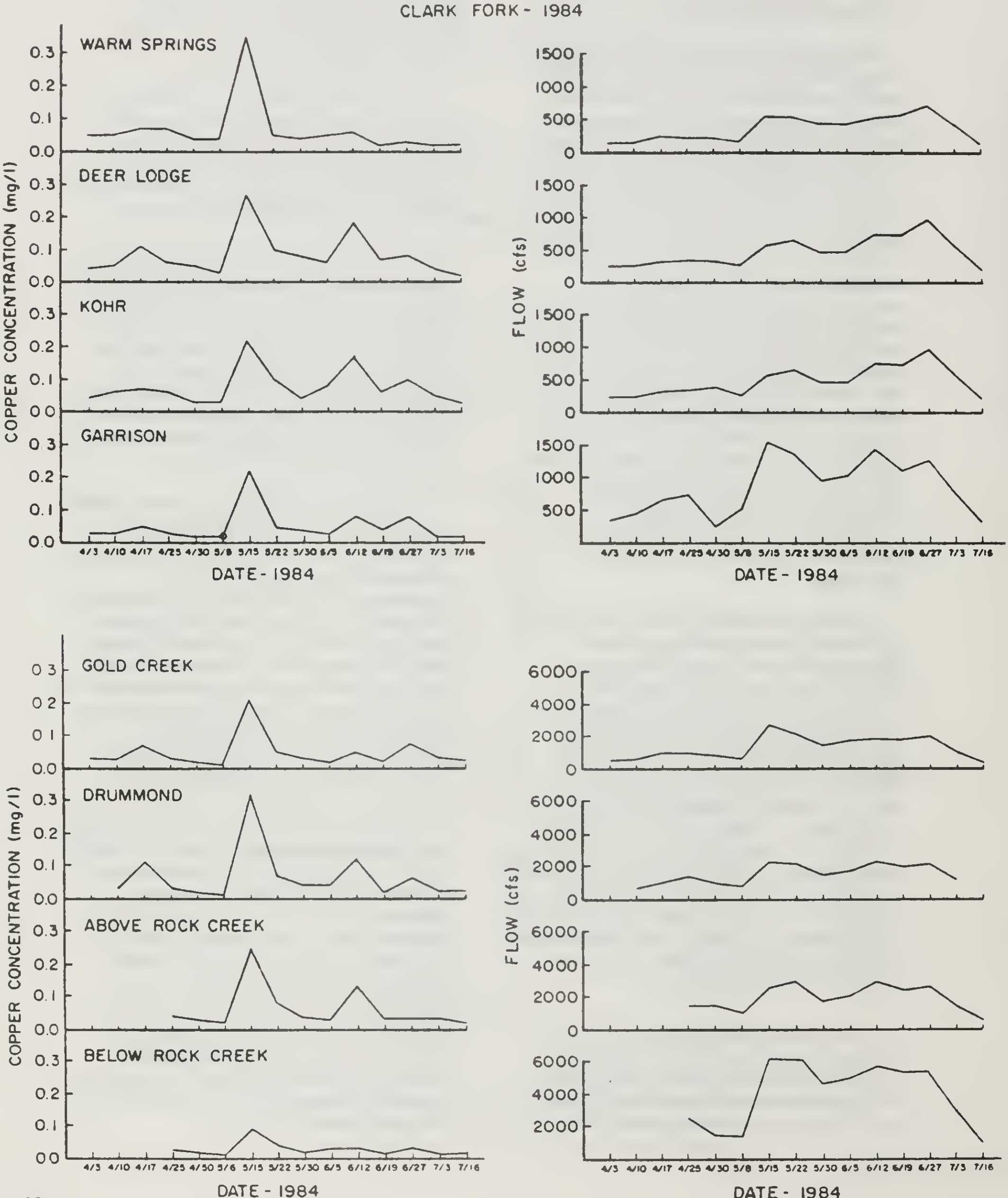
The toxicity of copper and other metals to trout varies with water hardness, species of trout, and life stage of trout. In general, trout embryos are more sensitive to metals than are adult fish. Brown trout embryos are more tolerant of copper than rainbow trout, and brook trout are less tolerant than rainbows (Sauter and others 1976; McKim and others 1978). As water becomes softer, the toxicity of metals increases.

Above the Little Blackfoot River, DHES classifies the Clark Fork as a Class C1 or C2 stream. This classification allows metals concentrations to exceed criteria recommended by the EPA for the protection of aquatic life. Below the Little Blackfoot River, the Clark Fork is a Class B-1 stream. The EPA acute toxicity criteria reflect the concentrations recommended for fish survival over the short term; average concentrations over a one-hour period should not be greater than the recommended criteria or occur more than once every three years.

Copper concentrations considered acutely toxic to trout have been exceeded during the winter and spring between Warm Springs Creek and the Little Blackfoot River, although between the Little Blackfoot and Milltown these concentrations have been exceeded only during the spring (Tables 1 and 2 in Appendix D). Tributary inflow during the winter months dilutes the copper enough to avoid toxic levels in the Clark Fork between the Little Blackfoot and Milltown. In the springtime, flows are high enough to resuspend metals from the Clark Fork floodplain.

FIGURE 4-2

Figure 4-2 Copper concentrations and flows at four locations on the Clark Fork between April 3 and July 16, 1984.



Prolonged exposure to copper at concentrations more dilute than the acute toxicity criteria also can kill fish. The EPA has set criteria for prolonged (chronic or over a 4-day period) exposure of fish to metals. These chronic levels are lower than the acute toxicity levels, and they do occur in the Clark Fork.

Bioassays are another way to look at the effects of decreased water quality on aquatic life. These assays expose fish to river water over a period of time and record the death rate. Phillips (1987) conducted bioassays with fingerling rainbow trout along the upper Clark Fork. The fish were held in cages set in Silver Bow Creek and in the river above Warm Springs Creek, Bearmouth, Deer Lodge, Gold Creek, and Clinton. The tests were conducted between April and June 1987. Fish mortality was as high as 89 percent in Silver Bow Creek, but decreased markedly down to 3 percent at Clinton. Results of the bioassays are shown in Table 3 of Appendix D.

Only limited data are available regarding water quality of tributary streams in the upper Clark Fork basin. Most streams in the Flint Creek Range are generally of good quality, although a considerable amount of mining took place in the headwaters of the streams (Montana DHES 1979). In the 1979 DHES study, several tributary streams on the west side of the Flint Creek Range showed slightly elevated levels of phosphorus. These levels of phosphorus may be related to naturally occurring phosphorus in the geologic unit known as the Phosphoria Formation. Poor agricultural practices may also contribute to these elevated phosphorus levels (Montana DHES 1979).

Water Temperature

Warm water in streams can be detrimental to trout and other aquatic life. When water temperatures rise above 66 degrees F, a trout uses more energy in foraging than is contained in the food it consumes (Montana DFWP 1986b). Rainbow and brown trout do not grow at temperatures above 66 degrees F.

Summer water temperatures in the Clark Fork already exceed 66 degrees F. DFWP operated recording thermographs in the Clark Fork from 1977 to 1982. Stream temperature monitoring shows that temperatures rose above 66 degrees F 5.6 to 28.6 percent of the time in June, July, and August, depending on location. Elevated stream temperatures were encountered more frequently at downstream locations than at the Deer Lodge station. Results of this monitoring are summarized in Appendix D, Table 4.

Dissolved Oxygen and Nutrients

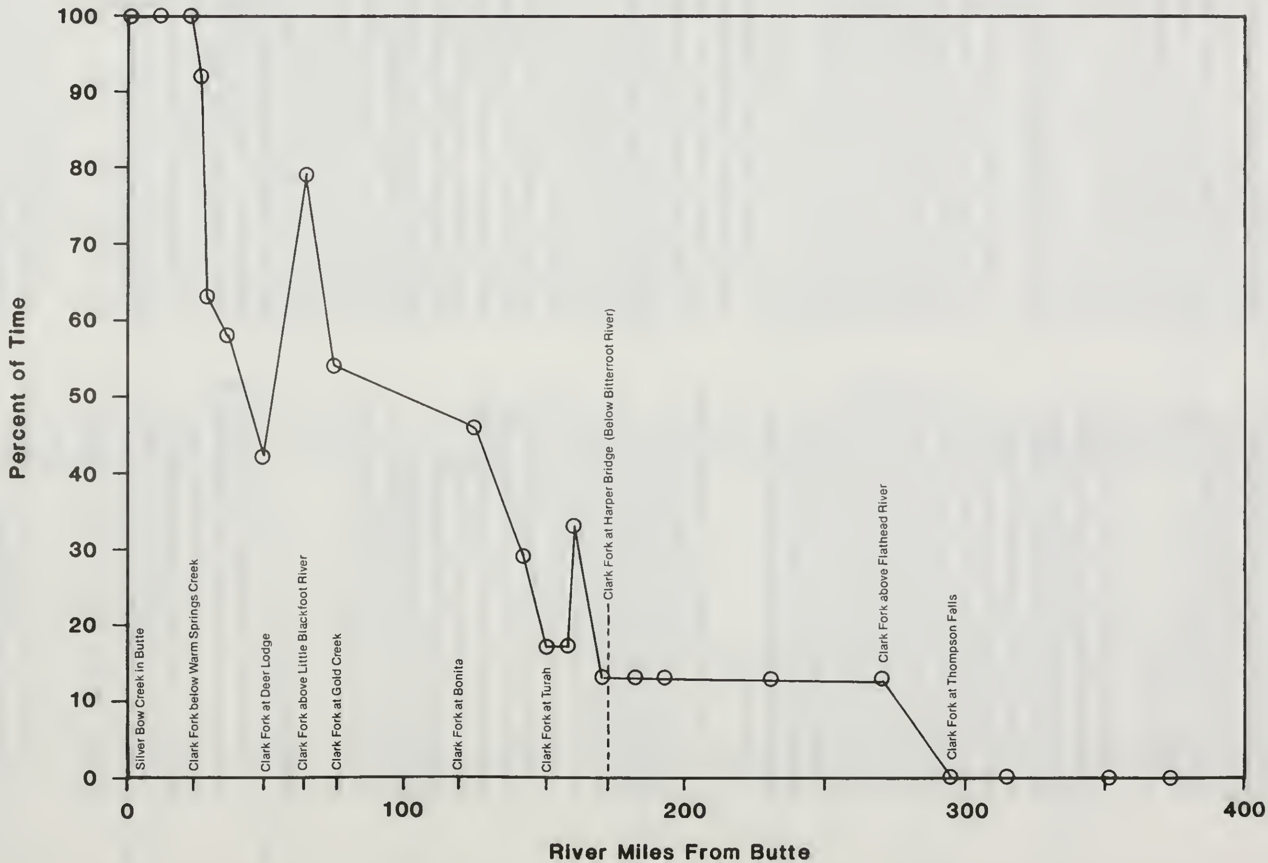
Algae and other aquatic plants produce oxygen via photosynthesis during the day. At night these same plants deplete dissolved oxygen via respiration, and as a result, dissolved oxygen levels are usually lowest during the early morning hours just before daylight (Watson 1987). Reduced levels of dissolved oxygen are detrimental to aquatic life.

Certain chemicals will reduce dissolved oxygen levels by promoting algal and aquatic plant growth. Nutrients such as nitrogen and phosphorus act as fertilizers for algae growing in a stream. As algae populations expand, fluctuations in dissolved oxygen concentrations can become more pronounced. This process is known as eutrophication. Municipal sewage systems are major sources of nutrients discharged to the Clark Fork. DHES data (Figure 4-3) show that phosphorus levels in the upper basin frequently exceeded EPA criteria. High phosphate levels may result in algae blooms and increases in other aquatic plant populations leading to reservoir eutrophication. Nitrogen levels above Warm Springs frequently exceeded criteria for prevention of nuisance algae growths (Figure 4-4). In most of the upper basin, nitrogen levels appear to be more limiting to algae growth than phosphorus levels. Runoff from sewage disposal and agricultural operations also contributes nutrients to the river (Watson 1987). Studies have just begun to determine the degree of nutrient loading in the basin from the headwaters to Lake Pend Oreille.

The dissolved oxygen concentrations in a river also are affected directly by stream temperature. Stream temperature determines

FIGURE 4-3

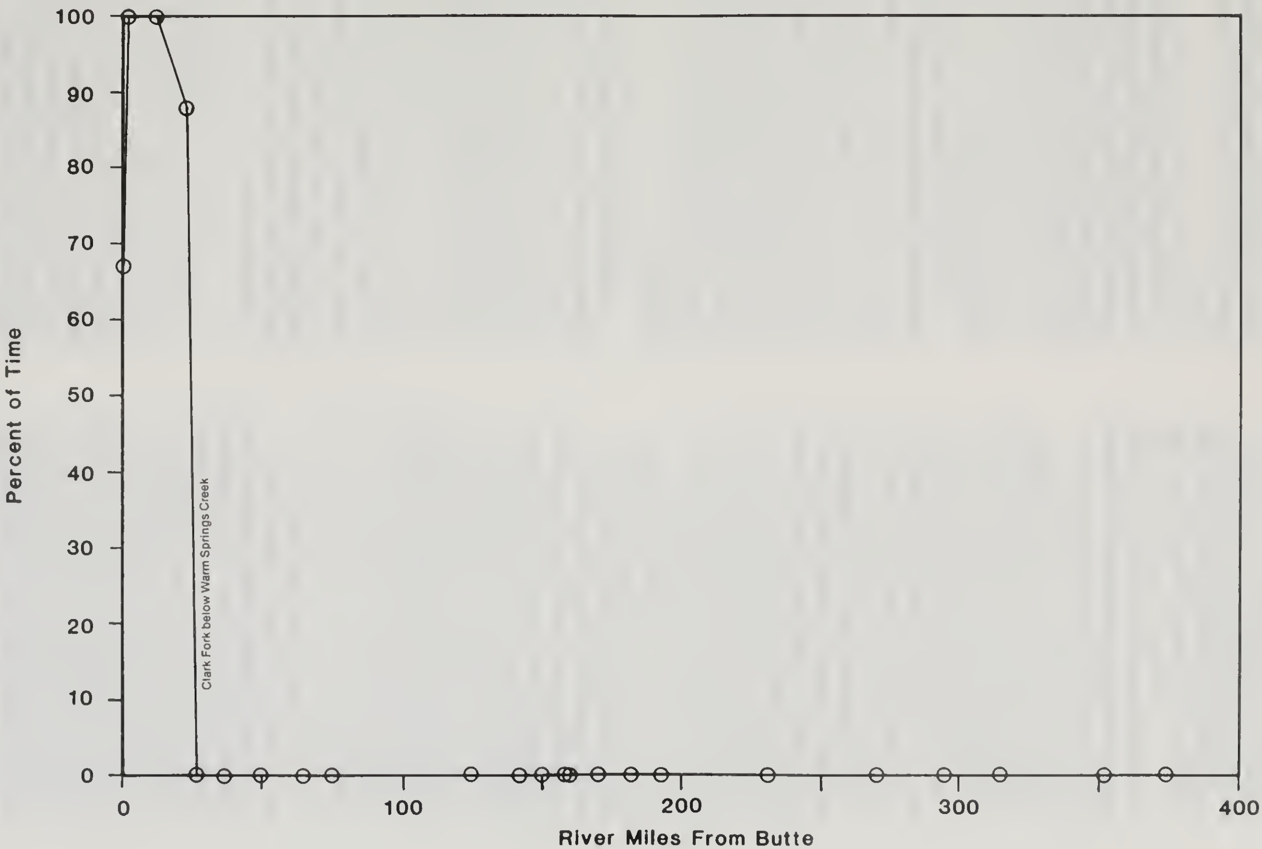
Frequency of total phosphorus measurements by stream mile in Silver Bow Creek and the Clark Fork from Butte, MT to below Cabinet Gorge Dam, ID exceeding the EPA criterion to prevent the development of biological nuisances and to control cultural eutrophication* for the period July, 1986 through June 1987.



*Concentration that should not be exceed in streams entering lakes or reservoirs. EPA 440/5-86-001, May, 1986.

FIGURE 4-4

Frequency of total soluble inorganic nitrogen measurements by stream mile in Silver Bow Creek and the Clark Fork from Butte, MT to below Cabinet Gorge Dam, ID exceeding the MDHES criterion to prevent the development of nuisance algae* for the period July, 1986 through June, 1987.



*Concentration that should not be exceeded in streams. Water quality criteria matrix in MDHES. 1986. Montana Water Quality — The Montana 306(b) Report, May 1986.

how much dissolved oxygen will be held in solution. For example, water at 10 degrees C (50° F) can hold 11.33 mg/l dissolved oxygen, while water at 30 degrees C (86° F) can hold only 7.63 mg/l dissolved oxygen.

Dissolved oxygen concentrations in the upper Clark Fork are depressed below levels recommended for the protection of aquatic life. This is especially true during the summer in low-flow years. Measurements of dissolved oxygen presented by DFWP (1986b) and Watson (1987) show that in the summers of 1973, 1976, 1977, and 1987 (low flow years), dissolved oxygen levels fell below state water quality standards established to protect aquatic life (Appendix D, Table 5).

During the summer of 1987, additional samples were taken to further understand the severity of dissolved oxygen depletions during a low-flow year. Hourly measurements by DHES at nine stations along the upper river on July 29 and 30 showed that dissolved oxygen levels were lowest between midnight and 2:00 a.m. Weekly predawn samples (4 a.m. to 7 a.m.) were taken in July and August. Dissolved oxygen levels in these predawn samples ranged from 6.3 to 8.4 mg/l. Dissolved oxygen levels were below the state standard in mid-July but increased during a period of unseasonal rains and increased stream flow in late July. Rain and cooler nighttime temperatures further increased river flows and decreased water temperatures in August. As a result, predawn dissolved oxygen levels increased in August (Watson 1987).

Aquatic Insects

Aquatic insects are often used as indicators of environmental stress. Aquatic invertebrate populations and species diversity along the upper Clark Fork improved since 1972 (Hunter and others 1986), indicating an improvement in water quality. Aquatic invertebrate populations and diversity are lowest in Silver Bow Creek and increase somewhat between the mouth of Warm Srings Creek and the Little Blackfoot River. Elevated nutrients may contribute to lower species diversities at Deer Lodge and above the Little Blackfoot River (McGuire 1987). Species diversity increased below the Little Blackfoot River and Rock Creek, indicating a healthier stream environment, possibly because of dilution from relatively clean tributaries.

Tributary streams originating in the Flint Creek Range generally are of good quality. Species diversity indices reported by the Montana DHES (1979) for streams in the Flint Creek Range generally indicate a healthy variety of stream organisms.

Industrial Waste Disposal

Stone Container Corporation at Frenchtown produces large volumes of liquid wastes. These wastes are treated and then disposed of in the Clark Fork near the plant site below Missoula. Plant discharges are regulated by EPA and DHES. The most restrictive standard is the DHES color standard which limits the extent to which Stone's discharges can affect the color of Clark Fork water. The DHES color standard is based on the capacity of Clark Fork flows to dilute concentrations of colored discharges.

Stone's color treatment operations are expensive ($1 million to $2 million per year). Discharges from the mill are prohibited between July 15 and September unless flows are greater than 4,000 cfs and at other times when flows in the river are less than 1,900 cfs. When this happens, plant wastes must be stored, then treated and discharged when river flows increase. Winter flows in the Clark Fork below the confluence of the Bitterroot River are less than 1,900 cfs in fewer than 2 years out of 10. (See Table 1 in Appendix B for a description of the frequency of flows less than 1,900 cfs on the Clark Fork below the confluence with the Bitterroot River.)

State water quality standards affecting Stone Container's plant operations are based on low-flow conditions in the Clark Fork in past years. Upper basin flows influence the stringency of DHES standards. Should consumption of water in the upper Clark Fork basin further reduce flows in the mill's discharge area, more stringent standards might be adopted which could further restrict discharges from the plant (Horpestad

1988), thus influencing treatment requirements and the profitability of plant operations.

EPA limits Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS) of discharges from the mill. Currently, EPA regulations limit discharges that can affect the oxygen concentrations and turbidity of the Clark Fork. The allowable amount of such discharges is not based on flow levels in the river. This situation may change if present and proposed monitoring studies demonstrate a relationship between low-flow levels, nutrient loads, and algal growth problems in the river.

Municipal Waste Disposal

DHES has established standards for discharges of coliforms and chlorine from wastewater treatment plants. These standards are determined by the ability of streamflows to adequately dilute the pollutants. Present studies of nutrient loading along the Clark Fork may ultimately result in state-enforced standards for nutrient discharges (such as nitrogen and phosphorus, which can increase algae growth rates).

EPA regulates BOD and TSS discharges from sewage treatment plants. Federal regulations limit pollutant levels in the discharged wastewater rather than how it is diluted by the river.

Twenty-one municipalities in western Montana use the Clark Fork and its tributaries for disposal of sewage wastewater. Several smaller sewer districts serving unincorporated residential areas also are permitted to discharge treated wastes into basin waterways.

City of Missoula

Missoula operates the largest sewage treatment system in western Montana. The recently upgraded facility treats an average of 6 1/2 million gallons of wastewater per day and is designed to treat 9 million gallons. The plant is expected to reach capacity by 2010, due to population growth and expansion of sewer service into new areas (Aldegarie 1987). When operating properly, the Missoula wastewater treatment plant complies with current state and federal discharge limits. In the fall of 1987, malfunctions caused the plant to temporarily violate permit requirements. The Missoula wastewater discharge permit was recently renewed.

City of Butte

Butte's metro sewer system treats municipal sewage through an activated sludge process and discharges treated wastewater into Silver Bow Creek (Piercy 1987). Discharges from the metro sewer plant are not currently regulated by DHES standards because Silver Bow Creek is a class "E" stream. The metro sewer system treats its wastewater sufficiently to meet a class "C" water quality designation (Pasco 1987). DHES data indicate that Butte's treated wastewater may be a major source of nutrients in the upper basin (Ingman 1987).

City of Anaconda

The community of Anaconda operates a newly constructed, aerated lagoon system which provides primary and secondary wastewater treatment. This system currently discharges into the Opportunity Ponds, which are owned by ARCO, the successor of the Anaconda Company. The ponds are not classified as a state water body and discharges into them are not regulated by DHES water quality standards. Discharge of city wastewater into the ponds will have to be stopped in order for ARCO to complete Superfund-related cleanup activities.

The Anaconda-Deer Lodge local government is evaluating the potential for discharging into Warm Springs Creek or into the Clark Fork. In either case, wastewater discharges would be subject to DHES requirements that discharges cannot adversely affect existing water quality. Discharges also would probably be subject to state water quality standards which are based on dilution in the receiving stream. It is possible that expensive tertiary treatment would be necessary for discharges to meet water quality regulations.

City of Deer Lodge

Deer Lodge treats its wastewater in an aerated sewage lagoon and discharges it into the Clark Fork. At the system's current level of operation, Clark Fork flows provide dilution adequate to meet state requirements. During low-flow periods, Deer Lodge's discharges approach the limits set by state standards (Shewman 1987). The stringency of state standards for discharges could be affected by changes in river flow volumes due to increases in the consumptive uses of upstream water.

Drummond and Philipsburg

Drummond and Philipsburg operate nonaerated lagoons for sewage treatment, and discharge wastewater into the Clark Fork and Flint Creek. Present flows provide for more than adequate dilution of wastewater discharges. Unless major flow reductions occur, the systems are not in danger of violating state water quality criteria (Shewman 1987).

FISHERIES

The fisheries of the Clark Fork have been damaged by past mining activities. This is most clearly seen on the main stem of the Clark Fork. As recently as 1972, water quality was so bad in the Clark Fork immediately below Warm Springs that no trout could be found (Spence 1987). Dissolved metals are thought to have decimated fish populations (Watson 1985). Treatment ponds installed beginning in 1911 on Silver Bow Creek just above the mouth of Warm Springs Creek were partially successful in removing metals from Silver Bow Creek. Metals in the river below the confluence of Silver Bow and Warm Springs creeks continued to be high until 1972, when a treatment plant was installed at the Weed Concentrator, an ore processor in Butte (Tuesday and others 1987). The trout population below the Warm Springs ponds began to rebound after this time. In 1986, population estimates indicated there were about 2,300 brown trout per mile immediately below the treatment ponds.

Trout populations in other portions of the upper Clark Fork have not recovered as fully as those near the treatment ponds. The reasons for the relatively low trout populations in the Clark Fork are not completely understood, and there may be several contributing factors. Chronic exposure to low levels of dissolved metals, primarily copper and zinc, seem to be toxic to a portion of the trout populations in the Clark Fork (Phillips and others 1987). In 1987, severe thunderstorms washed metal-contaminated sediments from the river banks into the river. These short-term exposures to metals resulted in large fish kills near Deer Lodge. Other habitat conditions also limit trout populations in the Clark Fork. Among these are fine-grained sediments at Deer Lodge and Bearmouth that limit trout spawning and insect production (Phillips and others 1987), and severe reductions in flow during the irrigation season near Deer Lodge. Low dissolved oxygen levels and elevated temperatures also may contribute to depressed trout populations.

Table 1 in Appendix C shows the species present and an estimate of trout numbers on each reach of the river and stream where reservations are requested. The most dense trout populations are in the upper Clark Fork below the Warm Springs ponds. Farther downstream, trout populations were less than 50 per mile near Bearmouth in 1985.

In Reach 1 of the Clark Fork, trout populations are dominated by brown trout, although a few rainbow, cutthroat, brook, and bull trout are found. Numbers of trout in this reach vary from approximately 2,300 per mile immediately below the Warm Springs ponds to less than 150 per mile below Deer Lodge. The upper portion of this reach is ranked by DFWP as a Class 2 (high-value) stream. Below Dempsey Creek, it is ranked as a Class 3 (substantial) fishery. Reach 2 of the Clark Fork between the Little Blackfoot River and Flint Creek is rated as a Class 3 stream. Brown trout dominate the limited population of trout. From 1969 to 1982, trout numbers varied between 499 and 127 fish per mile. Elevated metal concentrations are the most significant water quality problem in this reach.

The least dense trout populations in the upper river are found in Reach 3 between Flint Creek and Rock Creek. DFWP estimates of trout numbers show that in 1979 and 1985, trout populations ranged from 48 to 123 fish per mile. This reach is rated as a Class 3 stream by DFWP. This reach also suffers elevated concentrations of dissolved metals during high flows, and the river water is warmed by thermal springs.

Reach 4 of the Clark Fork, the lowest reach where reservations are requested, begins at Rock Creek, which contributes relatively clean water to the Clark Fork, and extends downstream to the mouth of the Blackfoot River at Milltown Dam. This reach is rated as a Class 2 stream. From 1979 to 1985, trout numbers have varied between 309 and 479 fish per mile. Brown trout comprise about half the total trout population, followed by rainbow trout, which make up about 45 percent of the population. Cutthroat, brook, and bull trout also are present. Many juvenile trout are found in this reach.

Most tributary streams support resident fish populations that have not been as severely impacted as in the main stem. Most tributaries are rated as Class 2 or 3 streams with the exception of Harvey Creek, which is rated as a Class 1 stream. Some of the tributaries provide important spawning habitat for fish from the Clark Fork. The tributaries known to provide spawning habitat are Gold Creek, Lost Creek, the lower reach of Warm Springs Creek, and possibly the lower reach of Racetrack Creek (Montana DFWP 1986b).

Two tributaries of Georgetown Lake provide spawning areas for fish from the lake. The North Fork of Flint Creek is used for spawning by rainbow-cutthroat trout hybrids, rainbow trout, and brook trout. Kokanee salmon, brook trout, and rainbow trout from Georgetown Lake spawn in Stuart Mill Creek, a 1/3-mile long, spring-fed creek.

Spawning runs are believed to move from Warm Springs Creek into Barker Creek, where bull trout have been found spawning. Twin Lakes Creek also provides spawning habitat for fish from Warm Springs Creek.

Fish Species of Special Concern

DFWP lists three fish species in the upper Clark Fork drainage as species of special concern because of their limited numbers or distribution. They are westslope cutthroat trout, bull trout, and shorthead sculpins.

The westslope cutthroat trout is a native species with limited distribution in Montana and the rest of the country. It can crossbreed with rainbow trout. Genetically pure strains of westslope cutthroat trout are becoming less common. Pure strain westslope cutthroat have been found in Barker Creek, Twin Lakes Creek, the upper Little Blackfoot River (Reach 1), Dog Creek, lower Flint Creek (Reach 2) (Montana DFWP 1986b), and the North Fork of Willow Creek (Thomas and Workman 1986).

Bull trout are reported in low numbers in all four reaches of the Clark Fork, in the upper reach of Warm Springs Creek, Barker Creek, Storm Lake Creek, Twin Lakes Creek, Lost Creek, both reaches of the Little Blackfoot, Dog Creek, the upper reaches of Flint Creek, Boulder Creek, the North Fork of Flint Creek, and Harvey Creek.

The shorthead sculpin (a small fish that trout feed on) has limited numbers and/or habitats in Montana and is considered rare in the state (Montana DFWP 1986b). Shorthead sculpins are fairly widespread outside Montana. In the upper Clark Fork drainage, the species is found in the Little Blackfoot River.

VEGETATION AND WILDLIFE

Special Status Species

The upper Clark Fork basin provides habitat for peregrine falcons and bald eagles. The U.S. Fish and Wildlife Service classifies these species as endangered. Peregrines are observed occasionally as they migrate along the Clark Fork. Bald eagles winter along the river between Garrison and the Milltown Dam. Their numbers appear to relate to the availability of prey. Thus, more eagles winter in this stretch when fish

are abundant and open water areas are common (Montana DFWP 1986b; Flath 1987).

Two pairs of bald eagles currently nest along the Clark Fork. One nest was built near the mouth of Gold Creek. This nest was active in 1986 and 1987 but did not produce young. The other nest, several miles downstream near the mouth of Dunkleberg Creek, was active in the same years. Two young were fledged from this nest in 1987. Potential nesting habitat has been identified along lower Rock Creek and the lowest 2 miles of Flint Creek.

The Montana Natural Heritage Program (MNHP) maintains a list of plants and animals that are rare, imperiled, or critically imperiled in Montana. Six species that are found in the riparian habitats of the upper Clark Fork basin appear on this list (Table 4-3) (Montana DFWP 1986b).

Tailed frogs inhabit cold, fast flowing headwater streams. Common loons use the long, flat water reaches of the Clark Fork during their migrations. The imperiled plants were found at Nimrod Warm Springs near Bearmouth (MNHP 1987).

Vegetation and Wildlife of the Main Stem Clark Fork

The riparian vegetation of the Clark Fork above Garrison (Reach 1) has been altered from its natural condition by agriculture and mining. Irrigated and sub-irrigated hay meadows are common on the floodplain terraces adjacent to the river where the natural vegetation has been removed. These managed meadows are dominated primarily by smooth brome, meadow foxtail, redtop, and Kentucky bluegrass (Montana DFWP 1986b) (see Appendix C for scientific names).

Metal toxicity from mining spoils deposited on river banks and oxbows has killed or severely stressed vegetation. The native plant communities among the spoils deposits are dominated by willows, river birch, and an occasional cottonwood. Understory species include rushes, sedges, introduced hay-meadow grass species, tufted hairgrass, and various forbs (Montana DFWP 1986b). The result is a poorly developed riparian forest with several strata of shrubs

Table 4-3. Rare or imperiled Montana species associated with riparian habitats of the upper Clark Fork basin.[a]

Common Name	Scientific Name	MNHP Classification
Tailed frog	*Ascaphus truei*	Rare in Montana/secure globally
Common loon	*Gavia immer*	Rare in Montana/secure globablly
Peregrine falcon	*Falco peregrinus*	Critically imperiled in Montana/vulnerable to extinction throughout its range
Bald eagle	*Haliaeetus leucocephalus*	Imperiled in Montana/vulnerable to extinction throughout its range
Giant helleborine	*Epipactis gigantea*	Critically imperiled in Montana/apparently secure globally but may be rare in parts of its range
Foxtail muhly	*Muhlenbergia andina*	Imperiled in Montana/apparently secure globally but may be rare in parts of its range

[a] Classified as rare, imperiled, or critically imperiled by the Montana Natural Heritage Program.

and trees. Plant species diversity appears to be low as a result of metals from waterborne spoils. Species resistant or adapted to metal toxicity tend to predominate (Montana DFWP 1986b).

Wildlife species using riparian areas include white-tailed deer, mule deer, beaver, mink, muskrat, and several species of waterfowl. Several ponds are managed for waterfowl production.

The riparian vegetation between Garrison and Drummond (Reach 2) is more diverse than that found between Warm Springs and Garrison. A closed canopy forest of cottonwoods forms the uppermost tier of vegetation. Willows, river birch, red osier dogwood, rose, alder, and chokecherry form the shrub-dominated stratum. Understory vegetation is similar to that in the Warm Springs to Garrison Reach in that introduced grasses (quackgrass, Kentucky bluegrass, smooth brome, and redtop) are abundant. Forb diversity appears to increase in this river reach as compared to the upper reach. Riparian vegetation has been overgrazed by livestock in some areas and replaced by riprap in others (Montana DFWP 1986b).

White-tailed and mule deer inhabit riparian areas of this river section (Montana DFWP 1986b). A corridor extending along both sides of the river for roughly 3 miles below Gold Creek has been identified as deer winter range (McCleerey 1987). Elk also are found along much of the floodplain between Jens and Drummond, especially near the Wallace ranch (Montana DFWP 1986b). Several species of waterfowl are present, as are beaver, mink, and muskrat. In 1986, DFWP counted 24 beaver food caches along this river reach. This count is the highest made since 1979 and higher than counts along other Clark Fork Reaches (Montana DFWP 1987).

Between Drummond and Rock Creek (Reach 3), native vegetation has been all but eliminated along the Clark Fork. Mature cottonwoods with understory of shrubs, grasses, and forbs occur only immediately adjacent to the river. Where the native vegetation has been relatively unaltered, there are montane plant species such as ponderosa pine and Rocky Mountain juniper. Alluvial material transported by side drainages into the Clark Fork creates well-drained soil conditions adjacent to the floodplain, which allows for the growth of plants adapted to drier regimes. The potential vegetational diversity of the narrow valley of the Clark Fork is high as a result of the diverse topography, landforms, and exposures that occur close to the river (Montana DFWP 1986b).

Deer winter range similar to that in the Garrison to Drummond river reach continues to Rock Creek. However, downstream from Harvey Creek, the range lies only on the north side of the river (McCleerey 1987). Both mule and white-tailed deer use the riparian areas throughout the year. Beaver, muskrat, and mink inhabit the river (Montana DFWP 1986b). Compared to previous counts in this reach, the 21 beaver food caches counted in 1986 suggest a growing beaver population. Only one beaver cache was found in 1980 and four in 1982 (Montana DFWP 1987). Waterfowl inhabit the main stem, the isolated channels, and spring-fed sloughs. Ospreys nest in the Bearmouth area (Montana DFWP 1986b).

From Rock Creek to Milltown Dam (Reach 4), dense cottonwood stands and woody shrubs dominate undisturbed areas, while open cottonwood stands and grasslands dominate developed grazing lands. Well-developed canopies of shrubs and young trees provide excellent wildlife habitat. Willows are the dominant shrubs, but diversity is provided by rose, chokecherry, snowberry, gooseberry, mountain maple, and elderberry. Forb and grass cover are provided by both introduced and native species, with numerous pioneer and weed species occurring on gravel bars and disturbed sites (Montana DFWP 1986b).

Ospreys nest along the river near Clinton. Waterfowl, including Canada geese, also nest in the reach. The largest concentrations of waterfowl are in Milltown Reservoir and in the Clark Fork just upstream from it. Beaver, muskrat, and mink inhabit much of the reach (Montana DFWP 1986b). The nine beaver caches counted in 1985 and again in 1986 indicate a stable beaver population

(Montana DFWP 1987). White-tailed and mule deer are common in the riparian zone (Montana DFWP 1986b).

Vegetation and Wildlife of the Tributaries

Tables 2 and 3 in Appendix C present information on the wildlife and vegetation resources of tributaries that would be affected by the reservation process. Information on GCD's proposed reservoir site is also shown.

Most irrigable land in the upper basin is within 2 miles of the Clark Fork, Little Blackfoot River, or Flint Creek (Elliott 1986; Montana DFWP 1986b). Vegetation and wildlife are therefore similar to those described in the Clark Fork narrative or in the appendices. Other irrigable lands are found along Cow Creek, Lower Willow Creek, and north of the Little Blackfoot River. Information for the proposed North Fork of Lower Willow Creek Reservoir site and Lower Flint Creek (tables C-2 and C-3) suggests the types of plants and animals found on irrigable land along Cow Creek and Lower Willow Creek. Plants and animals found along Snowshoe Creek (tables C-2 and C-3) suggest the types of plant and animal communities found north of the Little Blackfoot River on irrigable land.

RECREATION

Recreational Use of the Upper Clark Fork and Tributaries

The most comprehensive set of information on existing recreational use on the upper Clark Fork and three of its tributaries comes from an intensive study conducted by Hagmann (1979). This study included both direct observation of recreational use and questionnaires filled out by recreationists. The study was conducted from June of 1978 through May of 1979, and includes both summer and winter use. The Little Blackfoot River, Flint Creek, and Rock Creek were sampled to determine recreational use. Table 8 in Appendix D summarizes numbers of observed recreationists and completed questionnaires for this study.

Flow data indicate that flows in the upper Clark Fork were above average during the summer of 1978. What started out as a low-flow summer with flows averaging 80 percent of normal changed to a high-flow situation, with flows averaging 140 percent of normal in July, 113 percent in August, and 148 percent in September. There is no indication how the above-average flows may have affected the recreational use that was documented in Hagmann's study. Of the many study results, those describing the amount, type, and distribution of recreational use on the upper Clark Fork are presented below. Table 9 in Appendix D summarizes recreational activities for residents and nonresidents.

1. Fishing was by far the most popular recreational activity and was ranked first by 50 percent of those who completed a questionnaire. Eighty-three percent of the Montana residents polled and 53 percent of the nonresidents participated in this activity.

2. Rest and relaxation, tent camping, and recreational vehicle camping were also popular activities, but were far behind fishing as the preferred activity.

3. Boating was cited as the favored activity by 4 percent of the respondents, and another 3 percent cited boat fishing as their most common activity on the river.

4. Montana recreationists who use the upper Clark Fork and its tributaries are typically repeat visitors, with 30 percent using the area 3 to 9 times a year, and 32 percent 10 or more times.

5. The reason cited most often by Montana residents for selecting the upper Clark Fork or one of its tributaries was proximity to visitors' homes (24 percent), followed by fishing potential (22 percent). Non-residents selected the upper Clark Fork and its tributaries for a variety of reasons.

6. Montana residents comprised 69 percent of upper Clark Fork visitors. One quarter (25 percent) were visiting the upper Clark Fork study area for the first time, but half had been visiting for five or more years. Missoula visitors were most frequent (38 percent), followed by Helena, Butte, Anaconda, Clinton, and Deer Lodge.

7. Out-of-state visitors comprised 31 percent of total visitors, with most (74 percent) visiting for the first time.

8. Recreational use in the upper Clark Fork study area is concentrated at developed sites along the river, such as public and private campgrounds and areas with good vehicle access. Camping sites include Beavertail Hill campground and Bearmouth Chalet on the Clark Fork, and Kading campground on the Little Blackfoot. Fishing access is available at Turah and Kohrs Bend, with vehicle access at several bridges, including Schwartz Creek, Rock Creek, Gold Creek, and county bridges near Warm Springs.

9. It is likely that water quality plays a role in the distribution of recreational use along the upper Clark Fork. Excluding overnight campground use, Hagmann's study indicates that more than 60 percent of the summer recreational use occurs from Rock Creek to Milltown Reservoir and in the stretch above Deer Lodge. These two river segments contain better fish habitat conditions and higher water quality (Knudson and Hill 1978).

10. Survey respondents listed the Blackfoot and Bitterroot rivers as two other streams most often visited. This corresponds with Missoula being the main source for upper Clark Fork visitors.

Very little trend information is available on the amount and type of recreational use on the upper Clark Fork for the years following Hagmann's study. Data are mostly limited to estimates of use for developed recreation sites, and sketchy coverage in several statewide surveys on outdoor recreational needs. Information gathered elsewhere in the state since Hagmann's study continues to indicate the importance of fishing and water-based recreation to Montana recreationists (Wallwork and others 1980; Frost and McCool 1986; Montana DFWP 1986a; Duffield and others 1987).

<u>Recreation Along the Clark Fork Tributaries</u>

Most tributary streams of the upper Clark Fork receive some fishing use and typically contain good fisheries. While the main stem receives approximately 17,500 visit per year, tributaries receive approximately 24,000 (Duffield and others 1987). Developed Forest Service recreation sites along the upper Clark Fork tributaries include Kading campground on the Little Blackfoot, Racetrack campground on Racetrack Creek, and Flint Creek campground below Georgetown Lake. Numerous campgrounds are located along Rock Creek. Lost Creek State Park is on Forest Service land north of Anaconda.

<u>Missoula County Recreation Needs Assessment Survey</u>

Missoula is the major source of recreationists for the upper Clark Fork basin. In 1986, 304 households in Missoula County were surveyed to identify present recreational resources in the county and future needs (MacKay and others 1986). Although the survey focused primarily on differences in the recreational needs of urban, suburban, and rural residents, it does provide some information on water-based recreational activities of county residents.

Of all water-based recreational activities for Missoula County residents, swimming received the highest participation rate at 75 percent. This was followed by fishing, with a participation rate of 73 percent. River floating ranks third among water-based activities. One or more persons from 41 percent of county households in the survey floated a river in Missoula County in 1986--24 percent in rafts, 10 percent in canoes, 2 percent in kayaks, and 5 percent in more than one type of craft.

Missoula River Front Park

Recreational uses occurring along Missoula's River Front Park include several activities that are enhanced by the river's presence. Several walkways and access easements allow access adjacent to the river for strolling, biking, and viewing. Future development plans include a kayak park in the river, improved fishing access, and a possible viewing platform near the river (Behan 1987). Other recreational activities occur near the river at baseball and football fields, tennis courts, other parks, and a downtown plaza. Activities at these parks are not dependent on river flows.

A popular stretch of the river for floaters extends from Milltown Dam to Jacobs Island near the Van Buren Street bridge. This segment receives a large amount of use from city residents and university students. Jacobs Island is popular for picnicking and swimming, and as a take-out spot for floaters.

Recreation at Lower Willow Creek Reservoir

The Lower Willow Creek Reservoir and dam are owned by the Lower Willow Creek Drainage District, but access is open to the public. Current recreational use is mainly fishing, with year-round use. Swimming and some limited water skiing also are available. Gradual drawdown of the reservoir occurs from June to September in most years, with complete drawdowns occurring infrequently (Dinsmore 1987).

Related Recreation Studies

The importance of water for outdoor recreation activities has been documented in numerous studies. Craighead and Craighead (1962) found that water is a major attraction for outdoor recreation. A national study (Cheek and Field 1977) found that aquatic environments--rivers, lakes, and oceans--were the locations for 38 percent of outdoor recreation activities, with a maximum of 30 percent of the activities occurring there requiring the presence of water.

The recreational value of rivers extends far beyond fishing, swimming, and boating. Rivers enhance streamside activities, such as picnicking, hiking, and camping, and provide enjoyment to those who use only the riverbank or view the river from a distance (Kaplan 1977).

Of the water-based recreation activities that depend on instream flows, fishing stands out because of its long-standing popularity. In findings from four national recreation surveys conducted from 1960 to 1977 (U.S. Department of the Interior 1979), fishing ranked as one of the three most popular outdoor recreation activities. Fishing remains a popular activity for Montanans, with 56 percent participation according to a 1985 statewide survey (Frost and McCool 1986). Fishing is popular among all age groups, tapering off to 43 percent participation for those 65 years and older. In Hagmann's 1979 study of the upper Clark Fork, fishing was the most popular activity and was listed by 83 percent of surveyed Montana residents.

People fish for various reasons besides catching fish. Other reasons are rest and escape from the daily routine, enjoying nature, and experiencing tranquillity and privacy (Driver and Cooksey 1977, Moeller and Engelken 1972). The satisfaction derived from fishing depends on the presence of fish, but goes beyond simply catching fish (Driver and Knopf 1976). Several surveys have questioned recreationists regarding barriers to participation in fishing. Frost and McCool (1986) found that "lack of time" was mentioned by nearly two-thirds of respondents as the major barrier to participation in fishing. Clearly, rivers located near survey respondents' residences provide one opportunity to overcome this barrier.

River floating is another popular recreational activity that depends on instream flows, though it falls far behind fishing in participation rates. Several researchers have derived minimum depth and width criteria for floating craft on rivers. These two factors are most limiting in determining the level of boat use and type of craft on any river. Hyra (1978) lists 0.5 feet as the minimum stream depth for canoes and kayaks and 1.0 foot for rafts and inner tubes. Minimum stream widths are 4 feet

for canoes and kayaks and 6 feet for rafts. Cortell and Associates (1977) list a slightly lower minimum depth for canoes and kayaks--3 to 6 inches--and 1.0 foot for rafts and drift boats. Their minimum stream width is a more realistic 25 feet for canoes, kayaks, and rafts, based on the length of float craft.

ECONOMIC CONDITIONS

General Overview

The performances of local economies in the upper Clark Fork basin are reflected in historic employment patterns. In general, Silver Bow, Deer Lodge, Powell, and Granite counties have experienced long periods of decreasing economic activity, while Missoula County has generally experienced economic growth (Table 4-4).

Recent Trends

In the 1980s, Silver Bow, Deer Lodge, Powell, and Granite counties experienced major economic setbacks resulting from permanent closures of certain basic industries. The closure of ARCO's Anaconda Company operations in Butte and Anaconda and closure of the Milwaukee Railroad's repair facility in Deer Lodge reduced the importance of mining, smelting, and the railroads as dominant industries. The remaining industries that bring income into the four upper county economies are agriculture, tourism, utility, timber, and government activities (Montana Department of Commerce 1987a). Small-scale mining, manufacturing, and transportation activities still contribute to the economic base of the area, but nowhere near the level they did previously.

The net loss of over 3,000 high-paying basic jobs in the four upper counties has resulted in an overall decrease in the employment and income for area residents. From 1980 through 1987, average annual employment in the four-county area decreased from about 25,600 to 21,100 (Montana Department of Labor and Industry 1988). In 1986, total personal income for area residents is estimated to be $633 million (U.S. Department of Commerce 1988b); when inflation is considered, this is a 6 percent decrease from 1980.

The Missoula County economy is larger and more diversified than the economies of the other four upper Clark Fork basin counties. The Missoula County economy is subject to annual and seasonal fluctuations, but has grown over time. Important basic industries in the county include manufacturing, timber harvesting, transportation, agriculture, government (particularly the U.S. Forest Service and University of Montana), and tourism. The city of Missoula is also an important regional retail trade and service center (Montana Department of Commerce 1987a).

Employment in wood products manufacturing and by the state and federal governments has decreased notably in the 1980s, but the Missoula economy has continued to experience net increases in employment and personal income. From 1980 through 1987, average annual employment in the county is estimated to

Table 4-4. Employment by county, 1930-1980.

Year	Silver Bow	Deer Lodge	Powell	Granite	Missoula
1930	25,294	6,166	2,778	1,380	10,583
1940	18,034	5,005	1,950	1,248	10,338
1950	18,632	5,863	2,214	1,175	12,601
1960	15,952	6,223	2,359	1,150	16,223
1970	14,543	5,288	2,332	948	21,349
1980	14,871	4,846	2,492	985	33,264

Source: U.S. Department of Commerce 1988a.

have grown from 33,100 to 38,800. Total personal income was estimated to be $915 million (U.S. Department of Commerce 1988b), an inflation-adjusted increase of 8 percent over 1980.

Many of the new jobs developing in the basin are in service businesses where wage levels are typically much lower than in the mining, manufacturing, and transportation sectors. The aging of the region's population also has contributed to lower income levels.

Role of Clark Fork in the Regional Economy

Hydropower

The upper Clark Fork contributes water for operation of four downstream hydroelectric dams (see Chapter Three). The dams contribute to local economies through direct employment of persons involved in dam operation and electric transmission activities. The dams also benefit Montana economies by producing cheap electricity for use by businesses and individuals.

Agriculture

Agriculture accounts for approximately 2 percent of the total personal income generated in the upper basin counties of Deer Lodge, Granite, Powell, and Silver Bow. In Granite County, it contributes approximately 9 percent of the county income. The agriculture industry also accounts for an average of approximately 3 percent of the total employment in these four counties. The highest percentage occurs in Granite County with agriculture accounting for approximately 18 percent of total employment (U.S. Department of Commerce 1986).

The Clark Fork and its tributaries are important to agriculture in the upper basin counties. Over 70 percent of the crops grown in these counties are irrigated. The most significant crop grown is alfalfa. Irrigation significantly increases hay production for ranching operations in the upper basin. For example, in Deer Lodge, Powell, and Granite counties in 1984, average per-acre hay yields were 2.1 tons on irrigated fields and 1.3 tons on nonirrigated fields (Montana Department of Agriculture 1985).

The high percentage of irrigated hay corresponds to the dominance of livestock production in western Montana. Livestock production accounts for approximately 90 percent of the total farm income in the region (U.S. Department of Commerce 1986). The relationship between hay production and cattle production is less direct (Boyer 1988). Cattle prices have a major influence on the sizes of local cattle herds. In low hay production years, ranchers may be able to supplement hay supplies by using hay grown in previous years or by purchasing hay. Purchasing hay is avoided as much as possible because it adds to production costs.

Cattle ranching is an important economic element of Deer Lodge, Powell, and Granite counties. Ranching in the area has followed the statewide trend toward fewer, larger, and more productive operations. For decades the number of ranches and the number of persons employed in agriculture in the counties has steadily decreased, while the size of farms and ranches and productivity have generally increased. Local agriculture's ability to sustain local retail and service businesses is decreasing.

Forest Products Industry

The forest products industry is the largest industrial employer in western Montana. The industry exists because of an abundance of publicly and privately owned forest lands and because of the operation of major wood products manufacturing plants in the region.

A key to the overall viability of the region's forest products industry is the Frenchtown Mill operated by the Stone Container Corporation. The mill is located west of Missoula and relies on the Clark Fork for waste disposal. It is the largest linerboard manufacturing plant in the world and employs more than 700 workers, of whom 88 percent live in Missoula County. The plant's annual payroll in 1984 was $28 million (DHES 1985).

The plant is also important to the operation of other elements of the region's wood products industry. The Frenchtown plant uses wood waste to make pulp and paper and also for fuel. Payments made by the Stone Corporation to wood-waste suppliers enhance the economic viability of other wood products plants by providing an additional revenue source while also solving a waste disposal problem. The plant's operation indirectly adds to demand for timber production, adding jobs and income for persons working in the logging industry (DHES 1985). Federal employment is also linked to the wood products industry because of the relationship between timber production and employment in land management activities by the U.S. Forest Service.

Travel/Tourism

The Clark Fork and its tributaries contribute to the scenic beauty of western Montana. Tourism is an increasingly important industry in this region. The river is highly visible from Interstate 90 and enhances the region's image as an attractive place to visit.

In 1986, tourists spent an estimated $854 million in Montana. After adjusting for inflation, expenditures on travel in Montana increased by 14 percent from 1979 to 1986, an annual growth rate of 2 percent. During the same period, the number of persons employed by the state's travel industry is estimated to have increased 24 percent from 17,600 to 21,900 (Montana Department of Commerce 1987b).

The most recent county-specific study on tourism in Montana was conducted by the Old West Regional Commission in 1979. In 1979, travelers were estimated to have spent $104 million in upper basin counties, which was 16 percent of total traveler expenditures in the state. In 1979, an estimated 3,082 persons were employed by the upper basin's travel industry (Old West Regional Commission 1980).

Applying estimates of statewide growth in tourism and adjusting for inflation, 1986 traveler expenditures in upper basin counties were estimated to be $179 million and employment in the industry was 3,835 persons (Boyer 1988). In 1986, the travel industry is estimated to have accounted for between 3 percent and 4 percent of personal income and about 7 percent of jobs in the upper basin.

While growth in the upper basin's travel industry has benefitted the economies of the area, it has not offset the effects of cutbacks of some of the region's other basic industries.

Montana's Travel Promotion Bureau estimates that slightly more than half of the travel expenditures made in Montana are made by out-of-state residents (Montana Department of Commerce 1987b). The portion of total travel expenditures made by non-Montana residents has been increasing. Traveler expenditures generally benefit retail and service businesses (Table 4-5). Information on Montanans' mode of travel and expenditure patterns within the state are unavailable.

Many persons traveling in the upper Clark Fork basin are attracted to the state by its natural beauty, its wildlife, and the recreational opportunities these resources afford. Whereas few visitors are likely to perceive the Clark Fork and its tributaries as a major reason for visiting the upper basin, basin waterways do contribute to the overall package of scenery, wildlife, and recreational opportunities that attracts people to the area.

Table 4-5. Nonresident traveler expenditures in Montana, 1983.

Business Type	Percent of Total Expenditures
Hotels and motels	23.1
Campgrounds	1.7
Eating and drinking	24.7
Food stores	5.3
Sporting goods stores	1.7
Gasoline service stations	27.7
Amusement and recreation service	5.4
Other	10.5

Source: Dailey 1984.

Outfitting

Outfitting of hunters and fishermen is an important part of the state's travel and recreation industry. In recent years, the use of outfitters has increased substantially, particularly in western Montana where water, wildlife, and fishery resources provide the kinds of hunting and fishing experiences people are willing to pay for. A study of the industry for 1985 estimated that the state's outfitting industry generated $34 million in revenues for the state's economy (Taylor and Reilly 1986).

In recent years, the number of guided fishermen has been increasing faster than the number of guided hunters. Because the fisheries of the upper Clark Fork are generally inferior to other western Montana water systems, the upper Clark Fork receives only limited use by fishing outfitters. DFWP identifies about 20 outfitters as frequent users of the Clark Fork (Maloit 1987). Use of the river by outfitters has been increasing.

Mining and Metal Processing

The large-scale metal mining and smelting operations in Butte and Anaconda used the basin's surface water in the mining and processing of metals and in disposing of mining and smelting wastes. Some small scale mining operations continue to use surface waters.

With closure of ARCO's Anaconda Company operations, the mining and metal processing industries are no longer as prominent as they once were. As recently as 1979, over 3,000 persons were employed at the Anaconda smelter (closed in 1980) and its Butte-based mining operations (closed in 1983). The loss of basic jobs in the mining and metal processing industries has had major adverse economic effects in the upper portion of the upper Clark Fork basin.

ARCO sold most of its Anaconda Company holdings in the upper basin to Montana Resources Incorporated (MRI). MRI has opened mines in Butte, but at a much smaller scale than pursued by ARCO. MRI operates the Continental Pit and the Weed Concentrator, and employs 320 persons in Butte.

MRI uses a portion of water acquired from the Anaconda Company to operate the concentrator and in its leach heap recovery processes. MRI pumps water from Warm Springs Creek, below Silver Lake, for these purposes. MRI's open pit mining operations require little water (Tillman 1987). MRI is considering marketing its excess water to the Butte Water Company for use as drinking water, and to irrigators in Deer Lodge and Granite counties.

Much of the water MRI uses in its concentrator is recycled for use in the heap leaching processes and is not directly discharged into state surface waters. The company does not currently use its permit that allows for discharge of its operational wastes into Silver Bow Creek, but may do so at some time in the future.

Several small metal mining operations have operated recently in the upper basin. Two mines large enough to be regulated by the Montana Department of State Lands (DSL) do not consume surface water or dispose of mining wastes in Montana surface waters (Grady 1987).

It is possible that large and small metal mines may eventually be opened in the upper Clark Fork basin. The Montana Mining and Timber Corporation is seriously considering development of a gold and silver placer mine near Gold Creek in Granite County. The Pegasus Mining Company is evaluating the potential for redevelopment of the Beal Mine in the German Gulch area of Silver Bow County.

Market price of metals will determine whether new metal mines are developed and idle mines are reopened, and will influence the scale of new and existing mining operations. Most future metal mining operations are not likely to consume major quantities of water.

Population

The population of the five counties that are entirely or partially included in the

upper Clark Fork basin is estimated to be 132,000. The majority of the basin's population lives in Missoula County (population 77,700). The estimated populations of the other counties are Silver Bow, 34,000; Deer Lodge, 10,700; Powell, 6,900; and Granite, 2,700 (U.S. Department of Commerce 1988).

The overall population of the upper basin has increased in recent decades, though population trends for individual counties vary. Missoula County has experienced substantial growth, whereas Silver Bow and Deer Lodge counties have undergone sizable population decreases. Powell and Granite counties have experienced little population change (Table 4-6).

The basin is estimated to have lost population in the 1980s. Recent population losses reflect the poor performance of the region's economy. Since the 1980 census, more people have moved out of the five upper basin counties than have moved in. Nearly 10,000 more people moved out of the basin than moved into it in the first half of the 1980s. Only Missoula County has experienced an increase in the number of residents (U.S. Department of Commerce 1988a).

Most persons living in basin counties reside in incorporated cities or unincorporated urban areas adjacent to those cities. The Missoula urban area is the largest in this region of Montana. Butte is the second largest and Anaconda the third largest. Only 2 percent of the basin's overall population was classified by the 1980 census as being rural-farm residents. Farm and ranch residents are a larger portion of the residents of Granite (19 percent) and Powell (7 percent) counties than in other basin counties (U.S. Department of Commerce 1988a).

Community Development

The City of Missoula considers the Clark Fork to be an important urban amenity, both for the recreational opportunities it offers and for its aesthetic values. The river bisects the city east to west. As it enters the city, the Clark Fork separates the Missoula central business district from the University of Montana campus. Farther to the west the river is flanked by industries, warehouses, and residential land uses.

Until recently, many facilities adjoining Missoula's river front were run down. Contributing to this condition was the degraded water quality of the Clark Fork, which created an unattractive and unhealthy environment. Since the 1960s, the city and private investors have spent $21 million to acquire titles and easements, and to clean up and redevelop land along the river. The river front has become an important element of Missoula's overall economic development strategy (Badenock 1987). The city now uses

Table 4-6. County population trends, 1940-1986.

Year	Deer Lodge	Granite	Missoula	Powell	Silver Bow	Total for Basin	Total for State
1940	14,224	3,401	28,038	6,152	53,207	105,022	559,456
1950	16,553	2,773	35,493	6,301	48,442	109,562	591,024
1960	18,640	3,014	44,663	7,002	46,454	119,773	674,767
1970	15,652	2,737	58,263	6,660	41,981	125,293	694,409
1980	12,518	2,700	76,016	6,958	38,092	136,284	786,690
1986[a]	10,700	2,700	77,700	6,900	34,000	132,000	819,000

a denotes estimate

Source: Montana Department of Commerce 1985a, 1985b, 1985c, 1985d, 1985e, 1985f; U.S. Department of Commerce 1988a.

its river front to recruit new businesses and spur investment in the central business district. The aesthetics and recreational opportunities of the Clark Fork also are assets for the recruitment of students at the University of Montana.

Public Services

Anaconda draws most of its water from a well system. Backup water sources for the community are available from the lakes above Fifer Creek and from the MRI pipeline which delivers water from Warm Springs Creek below Silver Lake to the metal concentrator in Butte (Manning 1987).

Butte's primary water source is the Big Hole River, with supplemental supplies from two Clark Fork tributaries, Basin Creek and Pilgrim Gulch Creek (Larson 1987). The Butte Water Company currently is considering discontinuing use of Big Hole River water and converting to water supplied by the MRI pipeline (Cheleni 1988).

The City of Deer Lodge uses two deep wells for its primary water source. During peak use periods, the city also operates one shallow well and takes water from Tin Cup Joe Creek (Hillgenbrandt 1987).

The town of Philipsburg uses water from South Boulder Creek and Fred Burr Lake, which drains into Fred Burr Creek. South Boulder Creek flows into Boulder Creek above Maxville (Wells 1987).

Drummond does not have a community water system and potable water is supplied by shallow individual wells (Wells 1987).

Water for Missoula residents is supplied from wells operated by private water companies. Many of these wells are located near the Clark Fork. The interaction of flows in the Clark Fork with the Missoula aquifer has been documented by water chemistry results, well and river hydrographs, potentiometric maps, modeling results, aquifer testing, and mass balance results (Clark 1986). Recharge from the river to the aquifer apparently occurs year-round, although the vast majority occurs during higher flows. In Clark's study, well hydrographs appeared to be independent from flows in the river from October 1985 to January 1986. This was attributed to partial sealing of the river by fine sediments, anchor ice, and algae, which decreased opportunities for leakage through the river bottom. Low runoff has reduced flows in the Clark Fork over the last 2 to 3 years, and water levels in wells adjacent to the river have decreased by 3 to 5 feet (Woessner 1988). The aquifer under the city is sufficient to supply a much larger population than it does at present (Lukasik 1987). Many households in the unincorporated urban areas surrounding Missoula are served by private individual wells.

Taxation

Montana local government and schools depend more upon property taxes for their operating revenues than is common in most other areas of the nation. Property taxes account for an average of 44 percent of operating revenues for Montana local governments and schools, compared to a national average of 33 percent (Montana Department of Revenue 1987).

Per capita taxable values for upper basin counties are lower than state norms (Table 4-7). Federally owned lands, which are exempt from state and local property taxes, comprise a large portion of the total lands in each of the basin's counties.

After adjusting for inflation, the tax bases of all five upper basin counties decreased in value during the 1980s. Decreases in "real" taxable valuations result in part from changes in Montana tax laws, and from the industrial closures which occurred in the upper basin counties.

Agricultural land, products, and machinery comprise slightly more than 2 percent of the combined taxable valuation of upper basin counties. Agricultural property constitutes a notable portion of the taxable values of the basin's rural counties. In Granite County, agricultural property accounted for 18 percent of the 1987 taxable value. In Powell County, agriculture represented 12 percent of the taxable value

Table 4-7. Taxable values by county, 1986-1987.

	Taxable Value	Taxable Value of One Mill	Per Capita Taxable Value
Deer Lodge	$ 9,332,000	$ 9,332	$ 872
Granite	6,140,000	6,140	2,274
Missoula	114,535,000	114,535	1,474
Powell	13,690,000	13,690	1,984
Silver Bow	37,132,000	37,132	1,088
State	$2,308,229,000	---	$2,818

Source: Montana Tax Foundation, Inc. 1987.

for 1987. In Deer Lodge County, only 4 percent was agricultural, with less than 1 percent in Missoula and Silver Bow counties (Montana Department of Revenue 1987).

Most of the basin's agricultural tax base is provided by land classified as grazing and wild hay land, and by cattle. In Granite and Powell counties, irrigated crop land constitutes 1 percent of county taxable values. The average taxable value of an acre of irrigated land in the basin was $7.16 in 1986-1987 (Montana Department of Revenue 1987).

Houses and residential land constitute most of the tax bases of upper Clark Fork counties. Industrial property represents a significant portion of the tax bases of Missoula and Silver Bow counties.

ARCHAEOLOGICAL AND HISTORICAL RESOURCES

The upper Clark Fork region is believed to have been an important area to prehistoric people. The river and its tributaries probably served as travel routes in the search for food or for collection of stone for tools. The region provides several locations where flint, basalt, chert, and jasper could be collected for making stone tools and arrowheads (Choquette and Holstine 1982). Early Indians, including the Salish, Kootenai, and Pend d'Oreille frequently used the river and its tributaries. Other tribes, including the Snake, Bannack, Nez Perce, and Blackfeet, are believed to have occupied the area seasonally (Schwab 1988b, Montana DFWP 1984, Choquette and Holstine 1982). Archaeological evidence of use has been documented at 249 sites within the upper Clark Fork basin (Schwab 1988a).

The history of non-Indian people in the upper Clark Fork region is reflected in 352 documentable historical sites along the river and its tributaries. A wide variety of historical activities have occurred in the region, including fur trapping and trading, homesteading, and mining (Montana DFWP 1984). Much of the historical record is associated with the mining of gold, silver, and phosphate.

CHAPTER FIVE

IMPACTS OF THE PROPOSED RESERVATIONS AND ALTERNATIVES

INTRODUCTION

This chapter discusses the beneficial and adverse impacts of the Board granting all or part of the requested reservations, or denying the reservation applications altogether.

Predicting the impacts of a reservation is somewhat imprecise because of the uncertainty concerning future water availability as described in Chapter Three. Because of this uncertainty, two scenarios are analyzed in this chapter. The first describes the potential impacts of reservations when existing water rights constrain future consumptive use by limiting the amount of additional water that could be diverted. In the second scenario, water rights do not constrain future development.

Impacts resulting from DFWP's instream flow requests are described first, followed by a discussion of impacts associated with GCD's request for a reservation. Impacts of other possible Board actions involving less than the requested amounts or denying the reservations are described at the end of this chapter. Benefits and costs of the reservations are compared in Chapter Six.

IMPACTS OF GRANTING DFWP REQUESTS FOR INSTREAM FLOWS

DFWP's method to determine instream flow needs is described in Appendix A. For the most part, the DFWP methodology provides a reasonably accurate indication of abrupt changes in the amount of stream bottom that remains wet as flows change. Most of DFWP's instream flow requests (upper inflection point requests) are likely to provide adequate flows to protect aquatic habitat (Trihey 1988).

The Board cannot grant an instream reservation for more than 50 percent of the average annual flow of record on gauged streams (Section 85-2-816(6), MCA). DFWP requested more than 50 percent of the mean annual flow on the following streams with gauges installed: Clark Fork Reaches 1 and 2, Warm Springs Creek Reach 2, and a portion of Flint Creek Reach 1 (see Table 5-1). Except for Flint Creek Reach 1, DNRC does not feel that the limited gauging records reflect average flows over the long term.

Case 1: Existing Water Rights Constrain Future Development

Granting reservations to DFWP would have no adverse effect on current allocation of flows in the river. Because holders of existing water rights would still have a priority date ahead of DFWP, existing water rights would continue to be satisfied and low flow conditions would continue to occur in dry years. DFWP's reservations might pose no further constraint to future consumptive water uses because

Table 5-1. Instream flows requests and average flows based on stream gauges.[a]

	Instream flow requested (cfs)	Average annual flow of record[b] (cfs)	One-half average annual gauged flow (cfs)	Years of record	Period of record
Clark Fork - Reach 1 (Deer Lodge)	180	319	159.5	9	1978-1987
Clark Fork - Reach 2 (below Gold Creek)	400	628	314	10	1977-1987
Warm Springs Creek - Reach 2	40	53.7[c]	26.8	4	1983-1987
Flint Creek Reach 1[b]					
Southern Cross	50	30.1	15	47	1940-1987
Maxville	50	102	51	46	1941-1987

[a] Source: Montana DFWP 1986b; USGS 1987.

[b] As designated by DFWP, Flint Creek Reach 1 includes two USGS gauging stations. The upper station is located below Georgetown Lake at Southern Cross while the lower station is at Maxville.

[c] USGS does not publish average annual flows until 5 years of records are available, but an average annual flow of 53.7 cfs was calculated for the 4-year period of record.

existing water rights, if enforced, might limit water availability. During high spring runoff, a small amount of flow (in excess of WWP's water rights and reservations requested by DFWP) would be available for future consumptive uses. As described in Chapter Three, this water would be available for roughly 22 consecutive days in no more than 5 years out of 10.

Granting DFWP's requested reservations will give an additional degree of protection to water quality, fish habitat, wildlife and vegetation, and recreation because DFWP would gain legal standing to object to future water right changes. When a request is received for changing either the purpose of a water right or the place water will be diverted or used, legal notice is given to all water right holders. These water right holders, including DFWP, could have standing to object even if they hold a water right that is junior to the right for which a change has been requested. If DFWP can show on a case-by-case basis that any changes would adversely affect its reservations, then options available to industry, agriculture, and other water users to buy and sell existing water rights may be more limited in the future.

DFWP also might object to applications for new non-consumptive water use permits that may not be objected to by others. Non-consumptive water uses that would not affect existing hydropower production might affect instream flows. For example, a small offstream hydropower generation facility may be proposed that would reduce flows in a stream reach and adversely affect water quality, fisheries, wildlife, or recreation. While flows below the facility would not be affected, the reach between the diversion and where the water returns to the stream could be depleted. DFWP's objections may preclude such a new activity, once again limiting the options available to prospective water users. These potential obstacles to new water uses may impact economic development, thereby limiting any revenue increases to the state, local governments, and the education system. Currently DFWP objects to such proposed hydropower developments through the FERC licensing process rather than Montana's water use permitting system.

Case 2: Existing Water Rights DO NOT Constrain Future Water Use

In this section it is assumed that existing water rights do not constrain further consumptive water uses in the upper basin. The impacts of DFWP's proposed reservations are discussed in light of this assumption.

Water Quantity Impacts

Granting reservations to DFWP would have no adverse effect on current allocations or flows in the river. Holders of existing water rights would still have an earlier priority date than DFWP, existing water rights would continue to be satisfied, and low flow conditions would continue to occur. DFWP would gain legal standing and could object to both changes and the issuance of new water use permits if they conflict with the instream flow reservations.

Although DNRC knows of no plans for conflicting uses of water during winter, there is always the potential for new water uses to be developed. DFWP's instream flow requests would prevent future additional consumptive water uses during the period January 1 through April 30 on all the tributary streams but would not prevent consumptive water uses on the Clark Fork main stem.

It is a generally acknowledged rule of thumb that water has to be available at least 8 years out of 10 for irrigation development to be feasible. Table 5-2 presents data showing the difference between historic monthly flows that occur 8 years out of 10, and DFWP's request. Downstream hydropower water rights were not factored into this analysis. The data show that during August there would be no flows available for additional consumptive uses above the confluence of the Clark Fork and the Blackfoot River. Therefore, granting the DFWP requests would make new full-service irrigation development in the basin above the confluence of the Clark Fork and the Blackfoot River infeasible without storage of spring flows.

Table 5-2. Water available in excess of instream flow requests 8 years out of 10 for reaches of the main stem Clark Fork.[a]

Reach Location	Instream Flow Request				Excess Water Available (cfs)								
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1 Deer Lodge	167.5[b]	55.6	83.9	50.2	53.4	61.9	110.5	114.8	170.1	111.8	0	0	0
2 Below mouth of Little Blackfoot River	330[b]	0	0	0	0	0	0	106.9	427.7	271.7	0	0	0
2 Gold Creek	330[b]	28.3	63.6	4.8	0	43.9	119.8	213.6	598.9	377.8	0	0	0
3 Below mouth of Flint Creek	500	18.8	46.6	0	0	0	85.8	188.6	567.6	343.2	0	0	0
3 Above mouth of Rock Creek	500	103.4	111.3	38.4	0	39.1	136.8	301.6	520.4	581.4	0	0	0
4 Above mouth of Blackfoot River	600	244.8	244.6	133.0	84.6	188.2	293.0	582.6	1882.6	2084.8	332.4	0	101.6

[a] DNRC's analytical methods and more complete results are given in Appendix B.

[b] On Clark Fork Reach 1, DFWP requests 180 cfs, but one-half of the average annual flow of record is 167.5 cfs based on the USGS gauge at Deer Lodge. On Reach 2, one-half the average flow of record is 300 cfs based on the gauge at Gold Creek where DFWP requests a reservation of 400 cfs.

As shown in Table 5-2, during spring runoff, flows exceed DFWP requests at all locations along the Clark Fork in 8 years out of 10. In winter, water in excess of the DFWP request on the Clark Fork would be available for consumptive uses in the upper basin only below the mouth of Rock Creek in 8 years out of 10.

In contrast, DFWP's instream flow requests in the upper Clark Fork would reserve only about a fourth of the water that eventually flows through Missoula during summer months, and about half of present winter flows. The Blackfoot River contributes the majority of flows through Missoula. From the legal perspective, DFWP's instream flow requests on the upper Clark Fork would not provide protection to flows through Missoula because no reservations are requested below Milltown Dam. However, from a practical perspective, DNRC knows of no new large, planned consumptive uses between Milltown and Missoula, and reserved flows would continue to flow through Missoula until additional water use permits are granted.

The most likely, foreseeable cause of future depletions in the Clark Fork basin above Milltown Dam is irrigation development. Even with full development of sprinkler irrigation on the estimated 8,362 irrigable acres in the upper basin, average monthly flows would be reduced by less than 3 percent at Missoula. In practical terms the significance of protection afforded by DFWP's requested reservations would be very small below Milltown Dam given this level of depletion. If future depletions occur in the winter or otherwise exceed DNRC's estimates, then flows below Milltown Dam would be reduced accordingly. It is possible that cumulative depletions could eventually result in significant reductions in flow at Missoula and points downstream.

<u>Water Quality Impacts</u>

Instream flow reservations on tributaries and on the main stem would help protect existing water quality in the Clark Fork. The instream reservations would not improve water quality because they would neither reduce the levels of pollutants entering the river nor increase flows in the river to aid in dilution. However, maintaining instream flows is an important component in ongoing efforts to clean up the Clark Fork (Rubich 1987). By maintaining current levels of dilution, the proposed reservations facilitate other cleanup activities. Superfund efforts and other costly cleanup activities are underway on the upper Clark Fork, but it is too early to predict what improvements will be made and how these will affect the fisheries of the Clark Fork. The instream reservations would help protect the investment being made in cleanup activities.

<u>Fisheries Impacts</u>

Granting the requested instream flows should protect the aquatic habitat from reductions in flows beyond levels allowed under current water rights. However, the reservations by themselves will not correct other environmental problems that limit fish and invertebrate populations. For example, metal contaminated sediments along the Clark Fork and Silver Bow Creek still will be washed into the river during high spring flows or intense rainstorms unless other cleanup and reclamation efforts are completed. Springtime concentrations of these metals in river water currently exceed levels considered safe for aquatic life.

The instream reservations would not prevent the severe flow reductions and subsequent impacts to fish resulting from the exercise of existing water rights. Senior water right holders would continue to have priority in low flow years. The recorded low flow levels for each of the gauged streams are shown in Table 5-3.

<u>Wildlife and Vegetation Impacts</u>

Riparian habitats bordering the Clark Fork and its tributaries support abundant and diverse wildlife populations. The vegetation in these habitats depends on stream flow or associated groundwater. Granting the flows requested by DFWP would help to maintain riparian vegetation and wildlife at levels comparable to existing levels. The requested flows would not lessen the severity of existing low flow conditions but could prevent further appropriations from exacerbating the situation.

Table 5-3. Minimum flows in the upper Clark Fork basin.

Stream	Minimum recorded flow (cfs)	Period of record	Instream flow requested (cfs)
Clark Fork - Reach 1	25 (July 1985)	1978-1987	180
Clark Fork - Reach 2	64 (July, August 1985)	1977-1987	400
Clark Fork - Reach 3	118 (August 1985)	1972-1987	500
Clark Fork - Reach 4	408 (August 1986)	1979-1982	600
Warm Springs Creek - Reach 2	0.04 (July 1985)	1983-1987	40
Flint Creek - Reach 1			
Maxville	15 (February 1962)	1941-1987	50
Southern Cross	0 (November 1966)	1940-1987	50
Little Blackfoot - Reach 2	6 (August 1977)	1972-1987	85
Boulder Creek	3 (March 1964)	1939-1987	20

Source: USGS 1987

Reservations could indirectly help protect existing wildlife habitat by limiting water availability for agricultural and industrial development of land. However, the opportunity to increase the foraging habitats provided by irrigated cropland would be foregone. This loss could be viewed as a detrimental effect on deer and waterfowl.

Earth Resources Impacts

Granting the requested instream flow reservations would have no adverse effect on stream morphology because the reservations would not alter peak stream flows or sediment loads.

Land Use Impacts

Granting DFWP's instream flow requests would have no adverse effects on land currently irrigated with legally appropriated water. In fact, the establishment of an instream flow reservation contributes to the continued use of existing water rights. For example, in addition to protecting against future water right changes, an instream flow reservation makes it easier for a water right holder to protect that right against encroachment by junior appropriators (Montana DFWP 1986b). As long as the instream reservations are asserted and enforced, holders of pre-existing water rights may be less vigilant in asserting their own rights and possibly save time and money. However, existing water right holders should not depend on DFWP to protect their rights.

In low flow years, diversion structures on the upper Clark Fork and tributaries require additional maintenance. An instream reservation would not alter the amount of dewatering allowed under existing water rights, but it might limit further depletions during low flow conditions. The reservation would help ensure sufficient stream flow to supply existing rights and avoid a deterioration of water quality to the point that it could affect crop production. The amount of maintenance currently required on diversing structures would not change.

In some circumstances instream flow reservations might affect the expansion of irrigated agriculture. The magnitude of the impact depends upon the economic feasibility of bringing new lands under irrigation. Because of the economic risks associated with marginal irrigation projects, no irrigation projects in the upper Clark Fork basin pump water more than 1/2 mile from the source (Elliott 1986). About 8,362 acres of additional irrigable land have been identified in the upper basin. Most of this land is more than 1/2 mile away and 100 feet in elevation from the main stem Clark Fork or a major tributary. Therefore, the 8,362 acres of irrigable land should be considered an upper limit because it is unlikely that all these lands will be irrigated. Furthermore, the analysis did not examine possible effects of flow reductions on existing rights resulting from this development.

Any expansion of irrigated agriculture in the upper Clark Fork basin might have to rely on water storage projects. Such projects might not be precluded by the DFWP reservations because water for storage would be available during the spring runoff period.

Recreation Impacts

Granting the reservations requested by DFWP on the main stem of the Clark Fork and its tributaries would help ensure the current level of use and enjoyment of these streams. Granting the instream flow reservations at the requested flows for the four reaches of the Clark Fork probably would meet minimum boating guidelines (Hyra 1978, Cortell and Associates 1977).

In Missoula's River Front Park, several of the existing and planned recreation activities that take place are enhanced by the presence of water. Granting the requested instream flow reservations would help to preserve amenities the river corridor now provides. However, the level of protection is expected to be very small because the reservations do not legally protect flows below Milltown Dam.

Local Economic Impacts

The waters of the Clark Fork play a role in the basin's economy, although major changes in flows would have to occur to have a notable economic effect. Most foreseeable increases in consumptive water use would be relatively small and localized, yet over time the cumulative effect of numerous new water uses could impact existing economic activities. DFWP's instream reservation requests could restrict major reductions in flow and limit the accumulation of smaller reductions that might affect existing water users. Some existing businesses might benefit from the increased stability, but granting the instream reservations might also impair the development of new consumptive uses and related economic activities.

Industry Impacts

Maintaining existing instream flows could benefit downstream hydropower producers and industries that discharge wastes into the river. Hydropower producers rely directly on flows to generate electricity and revenue. DFWP's requested reservations could prevent further depletions in the upper basin, thereby helping to minimize reductions in power production and earnings. Waste dischargers, such as Stone Container's Frenchtown Mill, prefer the higher dilution capability of large flows because they can discharge wastes promptly and avoid the costs of waste treatment and storage. Stone Container is concerned that the cumulative depletion allowed by numerous future consumptive water use permits could further restrain their discharge practices, raising storage and treatment costs (Weeks 1988).

DFWP's reservations could also limit new industrial water uses. However, spring flows could still be stored or existing rights might be purchased.

Agriculture Impacts

New full service or supplemental irrigation projects might be restricted if DFWP's reservations are granted. DNRC receives about 10 applications for new

agricultural uses of water in upper basin counties in a typical year. Most requests are for small volumes of water, sufficient to irrigate 100 to 200 acres of land (Reynolds 1988; McLane 1988). In any case, applicants for new consumptive uses would have the option of purchasing existing water rights and changing the use or location of use. However, such action must not adversely affect existing water rights or the DFWP reservation if it were granted. If financially viable, expanded irrigation could improve the economic well-being of individual farms and ranches, but probably would not have substantial impacts on the overall economy of the basin.

Tourism and Recreation Impacts

DFWP's requested instream reservations could benefit the basin's travel, tourism, and recreation oriented businesses. Perpetuation of existing flows would help sustain current levels of scenic quality, fishing use, boating, and other recreational activities on the Clark Fork and its tributaries. If Superfund cleanup activities (discussed under "Water Quality") are continued and produce improvements, and instream flows are maintained, the Clark Fork could become more attractive for fishing, boating, and general tourism. With these conditions, it is possible that the related businesses could experience growth.

Taxation Impacts

DFWP's requested instream flow levels in the Clark Fork River and its tributaries would have no direct effects on property taxes or state income taxes. Maintenance of existing flows in the upper basin could indirectly help to sustain the profitability of business operations such as those of Stone Container Corporation and hydropower producers, thereby affecting corporation income and personal taxes paid to the state. In Missoula County, continuation of existing flows would help maintain river front characteristics that have attracted commercial and residential investments, which expanded local tax bases. Granting DFWP's requested reservations would have very small impacts on tax revenues below Milltown Dam because the reservations do not legally protect flows below this point.

Population Impacts

The populations of upper basin counties are influenced primarily by employment levels. A healthy economy promotes population growth, while an economic downturn generally leads to out-migration. DFWP's requested instream reservations would not affect the basin's economy as profoundly as other factors, but it could help to sustain businesses and industries that depend on existing flow levels. This, in turn, would add some stability to the general economy. Instream reservations probably would help maintain existing economic activity, and hence population levels, in the upper basin counties.

Community Development Impacts

DFWP's instream flow requests on the upper Clark Fork would provide no legal protection to flows below Milltown Dam, although reserved flows will continue to flow through Missoula until additional water use permits are granted. Thus, the granting of instream flow reservations could help to maintain the environment that has attracted recent investments to Missoula's river front area.

Public Service Impacts

Instream reservations could help maintain river flows needed to dilute municipal wastes from Deer Lodge, the Anaconda-Deer Lodge consolidated local government, Drummond, and Philipsburg. Instream flow reservations could indirectly help dilute municipal wastewater discharges from Missoula.

During periods of low flow, discharges from the Missoula and Deer Lodge wastewater treatment plants approach the limits of state enforced standards for dilution of pollutants. In Missoula, expected increases in the number of people being served by the sewage treatment system could make it more expensive to meet state discharge standards. Substantially lower

flows in the Clark Fork could cause the DHES to impose more stringent treatment requirements (Horpestad 1988), which could include tertiary treatment of municipal sewage discharges. The costs of additional treatment would be borne by the residents of the respective communities. Instream reservations would help prevent such cost increases.

Anaconda-Deer Lodge needs to find a new location for the discharge of its treated waste water. The Clark Fork and Warm Springs Creek are two of the more economical options for the discharges. Stream flows will influence the amount of treatment required to meet federal and state water quality standards. The applicability of the state's non-degradation standards to the Anaconda treatment facility makes maintenance of existing instream flows particularly important to Anaconda-Deer Lodge. If creek or river flows are insufficient for disposal of secondary treated sewage, more expensive alternative disposal methods or tertiary treatment methods may be required.

No instream flow reservation has been requested for Silver Bow Creek. The operation of Butte's Metro Sewer System would not be directly affected by the reservation. The existing Philipsburg waste water treatment system can treat sewage adequately even at substantially lower flows in Flint Creek.

Present studies by DHES may demonstrate a relationship between flow levels and nutrient problems associated with municipal waste water discharges. Should a relationship be demonstrated, DHES may adopt additional waste water treatment standards for nutrient-inducing discharges based on the dilution capabilities of the river. Such standards would serve to increase the importance of the flows during low flow periods, as the new standards could require more extensive treatment of wastes. DFWP's requested reservations could help prevent additional flow reductions that would exacerbate existing low flows.

Missoula's water is supplied from wells operated by private companies. DFWP's requested reservations would offer nominal help in maintaining existing flows in the Clark Fork that recharge Missoula's aquifer, assuming that no depletions occur below Milltown Dam. DFWP's reservations would not protect protect flows above 600 cfs that originate in the upper basin and typically occur in the spring months, when most of the aquifer recharge takes place.

History and Archaeology

Archaeological investigations have discovered numerous historical and archaeological sites on the benches and terraces above the Clark Fork and its tributaries. It is highly probable that additional sites could be discovered by survey efforts. However, the reservation of water for instream flows would not affect known historical or archaeological sites. There is a remote possibility that disturbance could occur if future events require DFWP to install gauging or monitoring stations to protect instream rights. The potential for impact to known or yet-to-be-discovered sites from placement of gauging structures could be avoided or minimized by conducting a ground survey for artifacts at each selected location.

IMPACTS OF GCD RESERVATION REQUEST

Introduction

The impacts of GCD's proposed reservation on water availability are presented in this section along with a discussion of the probable impacts associated with building the proposed reservoir and changing operations at the existing reservoir. Impacts associated with project construction are not expected to occur until 2002 and 2003, when the proposed dam would be built. Impacts associated with changes in flow patterns will not occur until after 2003. If the project is not built the following impacts will not occur.

Case 1. Existing Water Rights Constrain Future Water Use

If the Board grants GCD's reservations request, and existing water rights do, in

fact, constrain water use either before or after construction of the proposed reservoir, then GCD could not use its reservation. In terms of water use, there would be no impacts. However, GCD has described four approaches that might be applied to overcome constraints that could be posed by hydropower water rights in particular. These approaches are discussed below. If any of these approaches were successful, and GCD did develop the proposed project, then the impacts described under Case 2 would occur.

1. "Federalize the proposed Willow Creek project and in doing so subordinate downstream hydropower rights. The Federal license for these downstream hydroelectric projects already contain certain conditions which allow for their subordination to future upstream federal development, albeit at a cost." (GCD 1987)

   The licenses for all the dams on the Clark Fork stipulate that the use of water for hydropower production is subordinate to the use of water in federal water projects. In other words, if developers such as GCD can obtain federal sponsorship, the holders of hydropower rights could not object to the project, even though hydropower generation might be adversely affected. Only Congress can authorize a federal water project. In GCD's application, the steps required for federal authorization are outlined in some detail. Essentially, GCD would seek congressional authorization and funding through the Small Reclamation Project program (Public Law 85-984). This process requires a feasibility study including an environmental impact statement, approval from the Bureau of Reclamation, and Congressional action authorizing the project. While economic feasibility is not a strict requirement of the Small Project Loan program, the ability to repay the loan is. Based on DNRC's analysis as discussed in Chapter 6, the proposed project will not pay for itself. However, if the irrigators are willing to assume the risk of loss, or if state funding could be acquired to help pay for project development, there is some chance that the project could qualify for the federal program and be authorized. However, Congress and the current administration have adopted a policy of not authorizing any new water projects (U.S. Congress 1988).

2. "Negotiate an exchange of water rights between WWPC, MPC, and Hungry Horse Reservoir. Hungry Horse is a Bureau of Reclamation project that was established for multiple purposes which include irrigation." (GCD 1987)

   Water released from Hungry Horse Reservoir might be exchanged for water depleted by additional irrigation in the upper Clark Fork basin. This exchange water would make up for reduced flows at the Thompson Falls and Noxon Rapids power plants, but would not mitigate the depletions above Milltown Dam. Hungry Horse Reservoir is located on the South Fork of the Flathead River and is situated upstream from Kerr Dam. MPC's Thompson Falls Dam and WWP's Noxon Rapids Dam are not far from the Montana-Idaho border. The Bureau of Reclamation (USDI 1988) studied the effect of an additional 120,000 acres of irrigation development in the Clark Fork basin. The Bureau concluded that although power generation losses at Thompson Falls Dam and Kerr Dam could be mitigated and generation even enhanced by water releases from Hungry Horse Reservoir, generation losses at Noxon Rapids Dam could not. At 2,900 acres, GCD's proposed project would be substantially smaller than the amount of development examined in the Bureau's study. Even though Hungry Horse is authorized for irrigation uses, the Bureau was concerned that the existing allocation of Hungry Horse's storage for power generation and instream flows may be adversely affected by such an exchange. In addition, the Bureau

noted that exchanges of water would cause increased reservoir fluctuations at Hungry Horse.

3."Attempt to subordinate the WWP and MPC projects to upstream developments by inclusion of such terms in the relicensing of these projects. Currently some of these projects are up for relicensing." (GCD 1987)

Attempts to subordinate hydropower water rights to other upstream uses have not been successful. In past instances, DNRC has intervened in the FERC relicensing of hydropower facilities, requesting that FERC subordinate hydropower water use to all upstream consumptive uses. To date, FERC has not accepted DNRC's requests. However, FERC has the authority to make subordination a condition of federal hydropower licenses if it is deemed to be in the public interest. The purpose of past DNRC interventions was to ensure representation of state interests in specific FERC relicensing hearings. The state may or may not support such subordination requests in the future.

4."Subordinate hydropower uses to upstream developments via state legislation. This would require a prior amendment to the Federal Power Act." (GCD 1987)

No such changes are pending in the U.S. Congress, and none have passed the state legislature. However, western states are currently working to amend the Federal Power Act to give states a greater voice in FERC's decisions. Specific wording that would subordinate hydropower generation is not, however, contained in any draft legislation currently being evaluated by the western states. The outcome and possible policy changes associated with this effort are unknown at this time.

Case 2. Existing Water Rights DO NOT Constrain Future Water Use

The discussion of impacts resulting from the proposed dam on the North Fork of Lower Willow Creek is centered around changes in water quantity. In order to understand individual impact discussions, one must first understand how flows would change as a result of this reservation.

Current operations of the Lower Willow Creek reservoir account for the water use by senior water users on Lower Willow Creek in addition to the 2,900 project acres. In GCD's application, proposed dam operations did not reflect these additional uses. Based on discussions with the applicant (Dinsmore 1987), DNRC developed a reservoir operation model which accounted for both future water deliveries to project lands and historic deliveries to senior water right users. If the reservoir was operated in accordance with this model, the reliability of the proposed project would be reduced. The impact analysis that follows reflects the revised reservoir operation model.

Water Quantity Impacts

The purpose of GCD's reservation is to provide supplemental water to irrigate 2,900 acres of land currently receiving water from an existing reservoir on Lower Willow Creek. A new reservoir would be built on the North Fork of Lower Willow Creek to store this supplemental water (see Figure 2-2). DNRC developed a computer model to predict changes in flow rates (cfs) below the reservoirs and to predict the volume (af) of water stored in the reservoirs. A short description of DNRC's methods and model results can be found in Appendix B. DNRC reassessed project reliability based on discussions with the applicant. Project reliability is calculated as the percent of months that total irrigation needs on 2,900 acres of presently irrigated land are fully satisfied when both reservoirs are operated as a system. DNRC estimates the new dam would provide adequate irrigation water about 80 percent of the time compared to the 96 percent reliability estimated in GCD's application. The difference in

reliability is due to releases needed to satisfy the demands of water users with decreed rights on Lower Willow Creek.

Using the revised reservoir operation model, DNRC analyzed the actual flow pattern in the North Fork of Lower Willow Creek after project development. In the analysis of the proposed project, DNRC simulated several different operating schemes and studied their effect on streamflows and project reliability in the North Fork of Lower Willow Creek below the planned dam. It was determined that the project could be operated at near maximum reliability and still provide favorable streamflows below the dam. Simulated mean monthly reservoir releases from such an operating scheme are compared to historic flows on the North Fork of Lower Willow Creek in Table 5-4. In constrast, DNRC analyses also revealed that a very conservative operating scheme which stores as much water as possible during non-demand periods in order to maximize reliability would result in nearly complete dewatering of the North Fork of Lower Willow Creek for extended periods. Average monthly flows might be reduced to as little as 0.1 cfs.

As shown in Table 5-4, if the GCD project on the North Fork of Lower Willow Creek were constructed, the average estimated flows at the mouth of Lower Willow Creek would improve in all months except March, April, May, and June, when water is stored at the reservoirs and there is little return flow from the irrigated lands. Flows in Flint Creek also would improve, except for March, April, May, and June because of return flows from irrigated lands seeping back into Lower Willow and Flint creeks. The effect of project depletions during low flow years would be minor. Under low flow conditions, as shown in Table 4 of Appendix B, monthly flows near the mouth of Flint Creek would be reduced by less than 3 percent. An exception would occur during the peak flow month of May when, due to water storage activities, average flows near the mouth of Flint Creek would be reduced by about 8 percent.

The changed flow pattern in Flint Creek, as a result of the new project, conflicts with the DFWP instream flow request only in the months of March and April under average flow conditions. During these months, DFWP has requested all the flows of tributary streams to provide dilution water to the Clark Fork. DFWP has not requested an instream flow reservation on either the North Fork of Lower Willow Creek or Lower Willow Creek. At no other reaches are the changes in flow significant enough to conflict with DFWP's requested reservations.

Fifty acre-feet of storage capacity (the bottom 10-14 feet) have been provided in the proposed reservoir for sediment. It is unknown how long it would take for sediment to fill the bottom 10-14 feet. Until the bottom 10-14 feet are filled with sediment, the reservoir would not completely drain. After the sediment storage fills, the proposed reservoir is likely to drain by the end of summer. Water levels at the existing reservoir would not fluctuate as much as they currently do and the existing reservoir would tend to remain fuller for a longer period of time than it now does. Table 5 in Appendix B shows the estimated volume of water that would be stored in the proposed and existing reservoirs at the end of each month.

GCD raises the possibility of selling excess water from the project to other irrigators whose land is not included in the 2,900 acres of project land. DNRC analysis indicates that little excess water would be available for sale. A computer model simulated 35 years of reservoir operation, and the upper and lower reservoirs contained water at the end of the summer in only 14 years. This water was saved and used on project lands the following year in all but five years. By selling excess water, the supply of water saved for the following year would not be available and project operators would risk shortages. Although water would be available for sale in 5 out of 35 years, it is difficult to predict in advance how much runoff might occur the following year and how much the project will need. In addition, the five years when water could have been sold occurred in high flow years when there might not be a market for the water.

Table 5-4. Average monthly flow estimates before and after the GCD project.

	North Fork Lower Willow Creek Below Proposed Dam (cfs)		Lower Willow Creek Near Mouth (cfs)		Flint Creek at Mouth (cfs)	
	Before	After	Before	After	Before	After
October	2.7	2.1	25.3	29.9	197.3	202.2
November	3.1	2.4	14.5	16.9	149.2	151.7
December	2.8	2.0	8.0	9.3	113.2	114.5
January	3.0	2.1	5.6	5.9	93.3	93.7
February	3.8	2.1	5.0	5.2	99.0	99.2
March	4.7	2.0	6.4	5.5	111.5	110.6
April	11.5	2.1	19.7	13.0	166.8	160.1
May	32.3	3.9	95.3	65.5	405.6	375.7
June	18.6	12.9	37.9	28.3	407.9	398.3
July	4.0	35.6	13.5	13.9	87.5	87.7
August	1.7	19.0	16.9	25.6	55.2	61.0
September	2.0	1.9	32.9	38.7	168.1	174.7

Clark Fork

	Below confluence of Flint of Creek (cfs)		Below confluence Blackfoot River (cfs)		Below confluence of Bitterroot River (cfs)		Below Noxon Rapids Dam (cfs)	
	Before	After	Before	After	Before	After	Before	After
October	703.2	708.1	1775.6	1780.6	3079.4	3084.3	12214.7	12219.7
November	674.9	677.4	1701.9	1704.4	2973.3	2975.8	12814.5	12817.1
December	579.1	580.4	1550.4	1551.7	2700.4	2701.8	14053.2	14054.5
January	557.2	557.6	1465.8	1466.1	2487.2	2487.6	14651.4	14651.7
February	667.6	667.8	1645.3	1645.5	2773.1	2773.3	15658.1	15658.3
March	756.7	755.9	1997.2	1996.8	3294.1	3293.3	16563.0	16562.1
April	963.1	956.4	3789.2	3782.5	6334.0	6327.4	22889.9	22883.3
May	1724.4	1694.6	8918.2	8888.3	16238.3	16208.5	45557.6	45527.7
June	1822.5	1812.8	9691.5	9681.8	19485.2	19475.5	55376.5	55366.8
July	768.2	768.3	3722.9	3723.0	6866.9	6867.1	25166.2	25166.3
August	369.9	375.6	1667.3	1673.1	2569.9	2575.7	10135.0	10140.7
September	547.5	554.1	1637.8	1644.4	2679.3	2685.9	10254.6	10261.2

Water Quality Impacts

Average monthly flows in the Clark Fork below Flint Creek are predicted to increase slightly from July through March as a result of the proposed project as shown in Table 5-4. The capacity of Flint Creek water to dilute metals in the Clark Fork would increase slightly. April flows in the Clark Fork below Flint Creek are expected to be reduced an average of 6.7 cfs. However, in low flow years, the flows are not expected to change. The reduced flow in April, which conflicts with DFWP's request for instream flows, is not expected to significantly change the river's ability to dilute metals.

During spring runoff (May and June), average monthly flows in the Clark Fork would be reduced by 30 cfs or less (a change of less than 2 percent) with most of the change coming in high-flow years. In low flow years, there is expected to be little or no change in the river's springtime flow. Such changes are expected to result in unmeasurable changes to water quality. The dissolved oxygen problems in the Clark Fork below Flint Creek are not expected to change significantly as a result of the proposed dam on the North Fork of Lower Willow Creek.

Water in the reservoir would be warmed by the sun, so temperatures in the North Fork of Lower Willow Creek may be increased immediately below the dam in the late summer and fall. During spring and early summer, when water in the reservoir is cool, the temperatures of releases could decrease stream temperatures below the dam.

Sediment increases in the North Fork of Lower Willow Creek below the planned dam might occur during dam construction. GCD has not proposed any methods for reducing or avoiding sediment increases, although such matters would be dealt with during the final planning for the project.

Fisheries Impacts

Approval of GCD's reservation for the North Fork of Lower Willow Creek project would not cause impacts to fish and aquatic habitat until the dam is constructed. Construction is projected for 2002 and 2003. About 0.8 miles of stream habitat used by westslope cutthroat trout would be inundated by the 112-acre reservoir.

If construction causes increases in siltation below the proposed reservoir, spawning habitat and aquatic food production could be reduced at least in the short term. It is not known what erosion and sediment control practices would be implemented. A site-specific erosion and sediment control plan should be developed and implemented if the project is constructed.

The planned reservoir would be drained by the end of August in most years after the lower 10-14 feet have filled with sediment. Consequently, no self-sustaining fishery in the new reservoir is expected. The fishery in the existing Lower Willow Creek reservoir should benefit from the proposed project because the water levels probably will not fluctuate as drastically as they do at present. DNRC estimates that the lower reservoir would be drained in roughly 6 years out of 10, compared to the drawdown in August that occurs almost every year now.

Stream flows could change dramatically in a 2.9-mile reach of the North Fork of Lower Willow Creek below the proposed dam, depending on the final operating plan. This stream supports a population of pure strain westslope cutthroat trout, a species with a limited distribution. Loss of stream habitat for this species is considered significant. Provisions should be made in the final operating plan to protect minimum instream flows for this fishery if the reservation is approved.

Vegetation and Wildlife Impacts

GCD's planned reservoir on the North Fork of Lower Willow Creek would inundate 112 acres having moderately adverse impact on vegetation and beaver in this area. Vegetation in this area is primarily irrigated meadow, although willows lining the creek and patches of Douglas fir also would be lost. About 0.8 miles of beaver habitat would be destroyed and beaver movements up

and down the stream would be inhibited. The completed reservoir would benefit waterfowl by supplying a small resting area for migrating waterfowl, and geese and loons might nest there (Nielsen 1987). Draining the reservoir would limit its value to waterfowl. Increasing the productivity of currently irrigated cropland would not affect wildlife.

Earth Resources Impacts

The North Fork of Lower Willow Creek project would be constructed on tertiary sediments and alluvial materials. The nature of the bedrock foundation materials is not known and would require extensive borehole data prior to designing the structure. Depending on the final operating plan, large releases could exceed the capacity of the stream channel of the North Fork of Lower Willow Creek causing streambank erosion. If the Board grants GCD's reservation, provisions in the operating plan may be made to mitigate such impacts. Given no serious site constraints, the project would be a straightforward engineering exercise. No extensive canal works would be required, and the impacts of construction would be minimal.

Land Use Impacts

Granting the reservation requested by GCD for the North Fork of Lower Willow Creek project would reserve 11,165-acre feet of water. The project would inundate 112 acres of flood-irrigated pasture. Project water would be used to increase the productivity of 2,900 acres of irrigated hay and small grains. The project acreage could be expected to produce an average of about 2.5 tons (Dodds 1988) per acre of alfalfa under full service irrigation.

Recreation Impacts

Granting the requested reservation and constructing the planned dam could improve recreation opportunities at the existing Lower Willow Creek reservoir. Water levels at this reservoir would fluctuate less during an average runoff year, with complete drawdowns occurring less frequently (see Appendix B for complete reservoir storage data). Existing recreation activities would continue with increased reservoir levels, possibly extending use periods for the limited boating that occurs there. The year-round fishing that occurs there now would probably continue.

Recreation opportunities at the proposed upper reservoir would be minimal, with complete drawdowns predicted during August of average runoff years. Reservoir levels would be very low during the summer and fall of most years.

Local Economic Impacts

The most conspicuous local economic impacts resulting from the $9.9 million project would occur during construction of the dam. Employment of local and non-local residents would temporarily increase. Approximately 70 construction worker man-years would be required over a 2-year period and would provide about $2.5 million in wages. Construction activities would also increase expenditures at local businesses. Most off-site jobs generated by project construction would be located outside the county.

The extent of short-term economic benefits to Granite County would be influenced by the number of local residents employed in the construction jobs, and by the degree to which contractors purchase goods and services from local residents. Local businesses would benefit temporarily from greater consumer spending stemming from income increases for residents and expenditures by non-local construction workers. Some local ranchers might benefit from the sale of sand, gravel, and fill used in project construction. Granite County residents employed in construction of the projects would benefit personally from the short-term jobs and income created by construction activities.

The proposed irrigation project is not likely to have major, long-term effects on the overall economy of Granite County, but could affect the economic well-being of approximately 20 individual ranching families and have slight effects on the incomes of county businesses.

Granite County ranches are net-importers of hay. DNRC estimates that the North Fork of Lower Willow Creek project would facilitate the production of more than 2,000 tons of hay per year. The sale of additional locally produced hay to local cattle ranches would reduce the necessity of purchasing hay from out-of-county or out-of-state suppliers. Use of more locally produced hay would reduce loss of money to outside economies and would increase the local value added in county cattle production. The effect of the North Fork of Lower Willow Creek project on the incomes of participating local ranching families would generally depend on whether the additional rancher incomes resulting from greater hay production would exceed additional operating costs and project debt repayment.

DNRC's financial analysis of the Granite County proposal suggests that the revenues produced by the project would not be sufficient to cover project costs. If the project causes a net decrease in income for local ranches, it could exacerbate the problems of ranches experiencing financial difficulties. On the other hand, the GCD project is financially attractive for local ranchers if the costs of the project are subsidized with federal or state assistance. A subsidy could increase personal income of ranch families and local businesses serving the ranch families. The project is not likely to contribute to increases in employment by ranches or local businesses. The project may help ranches to continue as family operations, thus sustaining local jobs in the agricultural sector.

Taxation Impacts

The taxable value of irrigated hay land is determined by both land productivity and by the costs of water. The GCD project would improve hay production; however, the tax benefits of greater land productivity could be negated by high water costs.

At most the project would increase the taxable values of affected property from \$36,000 to \$59,000. Annual tax payments to the county would increase by about \$2,000. Combined county school taxes would increase by an estimated \$4,000.

Development of the dam and reservoir would remove small amounts of real and personal property from local tax bases. Land flooded by the reservoir would be lost from the Drummond and Hall school districts' tax bases. The loss of property would have little impact on the overall tax bases of the county or affected school districts.

Income taxes paid to the state would increase if the project increases income for ranchers and local businesses and would decrease otherwise. The state of Montana would experince a short-term increase in revenues from taxes paid by contractors and construction workers.

Population Impacts

Construction of the North Fork of Lower Willow Creek project could cause a small, temporary (two years or less) increase in population due to the presence of the construction workers employed in building the project. The project is intended to increase the income of ranches in the lower Flint Creek valley. If ranch profitability improves, the project might help a small number of local business operators and about 20 ranch families (Dinsmore 1988) to continue to live in the Flint Creek valley, but would have little impact on the overall population patterns of the county. If the irrigation project proves financially unsuccessful, it would reduce the profitability of local ranches and could hasten the decline in the number of family ranches operating in the county.

Community Service Impacts

Construction and operation of the project would have few effects on public services in Granite County. Travelers on state Highway 10A and on local roads would be inconvenienced by the temporary slowing of traffic during construction.

Community Development Impacts

The project would not affect the public and private sector redevelopment activities along the river front in Missoula.

Investments in commercial improvements and public parks and greenspaces would not be meaningfully affected by minor changes in water flows.

History and Archaeology Impacts

No historical or archaeological sites are known in the area directly affected by the proposed North Fork of Lower Willow Creek reservoir, although no survey of this area has been conducted. There is a moderate potential for discovery of archaeological sites. The type of sites most likely to be discovered include prehistoric campsites and stone tool making sites along the North Fork of Lower Willow Creek or on the terraces and benches surrounding the proposed reservoir. Due to extensive vegetative cover in the project area, it would be difficult to locate archaeological sites. The severity of impact from the project would depend on a site's significance and whether information important to furthering an understanding of the area's prehistory was lost by flooding or through disturbance during construction of the dam and clearing for the proposed reservoir.

The proposed project is located on private land. Montana's Antiquities Act would not require a cultural resource survey.

IMPACTS OF THE BOARD GRANTING DFWP LESS THAN THE RESERVATIONS REQUESTED

The Board may choose to grant instream flow reservations smaller than DFWP's request. In this section the impacts of granting instream flow reservations smaller than that requested by DFWP are presented. This discussion focuses on flows based on the lower inflection point (see Appendix A for a discussion of inflection points). In general, the lower inflection point of streams named in DFWP's application is approximately half of the requested instream flow (see Table 5-5). The lower inflection point was chosen for this discussion because it is thought to be the lowest flow that would still provide some level of protection to aquatic habitat and resources that depend on instream flows.

On Cable Creek and Stuart Mill Creek, DFWP did not suggest limits below which flows could not be reduced if minimum productivity is to be preserved. DFWP has described these streams as spring-fed creeks. DFWP's method for estimating inflection points and flow requirements does not work in spring-fed creeks because fluctuations in flow are limited.

Case 1. Existing Water Rights Limit Future Development

In this case, existing water rights would limit new consumptive water uses in the future. Granting DFWP instream flow reservations based on the lower inflection point would result in impacts similar to those described for granting DFWP the requested reservations when future water availability is limited. DFWP would still gain legal standing to object to changes in water rights as well as standing to object to applications for new non-consumptive water use permits.

Case 2. Existing Water Rights Do Not Constrain Development

Under this case, some flows would be available for appropriation for consumptive use if DFWP's requested reservations were granted based on the lower inflection point. Such reservations would not protect existing flows, but would provide a minimum level of protection for aquatic habitat. The level of protection would be reflected in its effect on fish populations. "In the case of game fish, a sport fishery could still be provided. For rare, threatened, or endangered species, the population would exist at low or marginal levels. In some cases, this flow level would not be sufficient to maintain certain species" (Montana DFWP 1986b).

Water Quantity Impacts

Granting instream reservations based on the lower inflection point would leave no water available 8 years out of 10 for future full-service irrigation in the basin above Gold Creek (Table 5-6). Storage of high spring flows would still be possible. Instream flow reservations based on the lower inflection point would increase the

Table 5-5. Comparison of the instream flows based on the low inflection point to DFWP's requested instream flows.

Stream Reach	DFWP requested instream flow (cfs)	Instream flow based on the Low Inflection Point (cfs)
Clark Fork Reach 1	180	90
Clark Fork Reach 2	400	200
Clark Fork Reach 3	500	180
Clark Fork Reach 4	600	300
Warm Springs Creek Reach 1	50	24
Warm Springs Creek Reach 2	40	16
Barker Creek	12	9
Cable Creek	10	
Storm Lake Creek	10	3[a]
Twin Lakes Creek	13	7
Lost Creek	16	8
Racetrack Creek Reach 1	26	13
Racetrack Creek Reach 2	3	1
Dempsey Creek	3.5	2.5
Little Blackfoot River Reach 1	17	5
Little Blackfoot River Reach 2	110	45
Snowshoe Creek	9	5
Dog Creek	12	6
Gold Creek	34	20
Flint Creek Reach 1	50	35
Flint Creek Reach 2	60	35
Boulder Creek	20	10
North Fork Flint Creek	6	3
Stuart Mill Creek	14	
Harvey Creek	5	2[a]

[a] A lower inflection point was not determined because the stream exhibits only limited fluctuations in flow. This is characteristic of spring-fed creeks.

amount of time that water is available for new irrigation. At Gold Creek, for example, the requested instream flow of 400 cfs would leave no water available for new irrigation in July, August, and September in 8 years out of 10. If the instream flow request is reduced to the lower inflection point flow of 200 cfs, then there would be water available for other new uses in all months except August. At various points on the Clark Fork between Drummond and Rock Creek, 20.6 to 103 cfs would be available for consumptive use in 8 out of 10 years during August, the most limiting month. In the fall and winter, more than 65 cfs would be available for other consumptive uses above Gold Creek in 8 years out of 10 without the need for new storage projects.

Water Quality Impacts

Granting DFWP instream reservations at the lower inflection point would set aside less water for instream flows than the proposed reservations. Such reservations would not specifically provide for dilution flows from tributary streams during the winter. Such an allocation of water would provide only a low level of protection for water quality during the winter months. During the winter, maintenance of flows from tributaries promotes dilution of metals in the Clark Fork. Although DNRC knows of no plans for conflicting uses of water during winter, there is always the potential for new water uses to be developed. Lower instream flows on tributaries during the

Table 5-6. Water in excess of instream flow based on low inflection points 8 years out of 10 for reaches of the Clark Fork.

Reach Location	Low inflection point instream flow (cfs)	Excess Water Available (cfs) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1 Deer Lodge	90	133.1	161.4	127.7	130.9	139.4	188.0	192.3	247.6	189.3	16.2	0	62.1
2 Below mouth of Little Blackfoot River	200	72.7	103.7	68.8	65.0	83.3	142.1	236.9	557.7	401.7	0	0	9.7
2 Gold Creek	200	158.3	193.6	134.8	129.7	173.9	249.8	343.6	728.9	507.8	24.1	0	46.3
3 Below mouth of Flint Creek	180	338.8	366.6	269.0	253.6	305.0	405.8	508.6	887.6	663.2	100.6	20.6	205.6
3 Above mouth of Rock Creek	180	423.4	431.3	358.4	276.0	359.1	456.8	621.6	840.4	901.4	211.3	100.3	275.8
4 Above mouth of Blackfoot River	300	544.8	544.6	233	184.6	788.2	393.0	682.6	2182.6	2384.8	632.4	286.4	401.6

winter would mean less water for dilution of metal contaminants in the Clark Fork, worsening existing water quality problems.

During the summer, maintaining instream flows helps prevent low levels of dissolved oxyen. Instream reservations based on the lower inflection point would provide only a low level of protection for water quality. Limited data collected during low flow years indicate that dissolved oxygen levels have been depressed to levels in violation of state water quality standards and below levels thought necessary for the maintenance of aquatic life. The interaction of nutrient-loading, algae growth, water temperature, and dissolved oxygen concentrations in the river is poorly understood. The low flow conditions associated with low levels of dissolved oxygen seem to occur about 1 to 3 years out of 10. Reservations based on the lower inflection point would allow further full service irrigation or other consumptive water uses below Gold Creek, which could reduce instream flows during the summer. Reduced instream flows may result in increases in stream temperatures especially in those reaches with little cool groundwater inflow. Less water would be available to dilute incoming nutrients which in turn could encourage algae growth and lead to more frequent violations of the state water quality standards.

<u>Fisheries Impacts</u>

Granting DFWP instream flow reservations based on the lower inflection point could allow for additional consumptive water uses on the Clark Fork and its tributaries below Gold Creek. Further depletions would reduce riffle habitat below current levels. As flows are reduced below the lower inflection point the stream bottom is exposed and dried out at a faster rate. Such a reservation would preserve a low level of aquatic productivity.

In theory, lower instream flows would reduce the number of fish that could be produced in a stream.

Lower instream flows on tributary streams used for spawning could reduce survival of young fish if future diversions were to take place. The consequences of reduced flow on these tributaries cannot be estimated precisely, but would depend in part on the timing and degree of flow reduction, the species spawning in a stream, and the alternate spawning habitat available on other nearby streams. Besides harming the fishery in a tributary, large reductions in the survival of young fish in a tributary could adversely impact fisheries in the Clark Fork, Georgetown Lake, Warm Springs Creek, or in Flint Creek. Fish in these streams and in Georgetown Lake spawn in tributaries.

Reductions in flow that could be allowed under smaller instream flow reservations might significantly reduce habitat of fish with limited numbers or distributions. Remaining populations of westslope cutthroat trout and bull trout are becoming scarce. These fish species already have limited distributions in Montana due to past fish stocking and habitat alteration. Other efforts are underway to protect these species' habitat from future development.

Wildlife and Vegetation Impacts

Providing instream flow reservations based on the lower inflection point would allow greater depletions than would the requested reservations. Thus, riparian habitats would be supported though protected at a lower level. Conceivably, low flows could degrade the habitat of water-dwelling mammals and waterfowl. These flows would be less harmful to wildlife than would the extreme low flows possible with no reservations. Limiting the water available for agricultural and industrial development would indirectly protect existing wildlife habitats from clearing or other disturbances. However, limiting irrigation development above Gold Creek would reduce the potential for new foraging opportunities for deer and waterfowl.

Earth Resource Impacts

Granting reduced instream flow reservations would have no direct effect on stream morphology because the reservations would not alter peak stream flows or sediment loads.

Land Use Impacts

Granting instream flow reservations less than those requested by DFWP would allow additional consumptive uses that could cause detrimental effects to existing irrigators. Irrigators might find it necessary to perform seasonal maintenance at diversion structures to ensure that the structures are low enough to divert water when flows are at low levels in the ditch or canal.

Recreation Impacts

Granting instream flows based on the lower inflection point for Reaches 1 through 4 of the Clark Fork may allow additional depletions resulting in a decline in the quality and enjoyment of existing recreational resources of the upper Clark Fork. Summer stream flows in Clark Fork Reaches 1, 3, and 4 could be significantly lower than the recorded average and median flows, assuming additional depletions would occur. Flows at the lower inflection point would not completely protect the existing resource. Game fish populations and fishing potential may decrease as low flow conditions reduce aquatic habitat. Streamside recreation activities that are enhanced by the presence of water would be reduced in low flow years as flows shrink. The lower inflection point flows for Reaches 1, 2, and 3 probably would not provide desirable boating experiences, with numerous "walk-throughs" of riffles being necessary.

Granting instream flows at the lower inflection point would not protect the recreational setting at Missoula's River Front Park. DFWP's claimed instream rights on the Blackfoot River and Rock Creek will continue to contribute historic flow levels to the Clark Fork below Milltown Dam. If there were no additional new depletions below this point, this would afford only a

low-to-moderate degree of protection. The slight changes in flows resulting from additional consumptive water uses in the upper Clark Fork basin would be too small to affect Missoula's River Front Park.

Economic Impacts

Additional consumptive water uses, as allowed by instream flow reservations at the lower inflection point, are not likely to have notable positive or negative impacts on the economies of the upper Clark Fork Basin.

Additional irrigation development could improve the financial viability of individual ranches, but is not likely to contribute to the creation of new long-term jobs in agriculture or agricultural service businesses.

If additional consumptive water uses result in only small depletions, they would not affect operation of Stone Container's Frenchtown mill. Such changes in flow might cause a very slight reduction of electricity generated at WWP's Noxon Rapids Dam, but return flows could slightly increase production at MPC's Milltown and Thompson Falls dams.

Slight changes in flows would not notably affect the tourism and recreational values of upper basin waterways, and therefore would not affect tourism and recreational oriented businesses. Similarly, if additional consumptive uses cause only small depletions, they would not affect commercial business activities on the Missoula river front area.

Taxation Impacts

Instream flow reservations at the lower inflection point are not likely to change state and local government, or public school revenue collections.

Population Impacts

Instream flow reservations based on the lower inflection point are not likely to have appreciable impacts on the number or distribution of people living in the upper Clark Fork Basin. General population patterns in the basin would only be affected if new consumptive water uses were to substantially alter the area's economy.

Community Service Impacts

Additional consumptive water uses as permitted by reservations at the lower inflection point would not be great enough to affect operation of the municipal wastewater plants in the Clark Fork basin.

Reservations based on the lower inflection point would provide only a small degree of protection to flows that recharge the Missoula aquifer. High flows in the spring, when most recharge occurs, would not be protected with or without instream reservations.

Community Development Impacts

Missoula's river front would continue to be an attractive area for new public and private sector investment if flows were not depleted below levels allowed by reservations at the lower inflection point.

History and Archaeology Impacts

Granting DFWP less water than it applied for would result in the same potential for impacts to historical and archaeological resources as DFWP's proposed action.

IMPACTS OF GRANTING GCD LESS THAN THE RESERVATION REQUESTED

The possibility of building a reservoir smaller than that described in GCD's application was examined but found to be less feasible than the original proposal. A smaller reservoir would result in a less reliable irrigation system and would generate higher construction costs per acre foot of water stored. Consequently, an environmental analysis for this alternative is not presented.

One other alternative to the proposed dam on the North Fork of Lower Willow Creek was considered. It might be possible

to purchase the rights for water currently stored in the Georgetown/Silver Lake system. The flows would then be diverted into a new canal just below Maxville extending 21.6 miles to a point just above the existing Northside Canal. Preliminary cost estimates based on a canal capable of handling 150 cfs indicated construction would cost $4.8 million, although a smaller canal might be able to meet the demands. Not included are costs for diversion works in Flint Creek, costs of acquiring water rights and operating the storage projects, and environmental impact mitigation costs. Preliminary cost estimates show this option to be more feasible than GCD's proposed dam on the North Fork of Lower Willow Creek. However, these costs, as with the proposed development, far exceed the returns resulting from increased hay production on project lands. Environmental costs might result from fluctuations in the level of Georgetown and Silver lakes, further flow reductions in Warm Springs Creek and tributaries, and possible erosion of stream banks in Flint Creek. This alternative is not economically feasible at this time. In the future, competing users may appropriate the water needed for this alternative, precluding the project even if it becomes economically feasible.

GCD's proposed reservation is based on converting project lands that are currently irrigated with a mix of flood and sprinkler irrigation to a system using only sprinkler irrigation. Therefore, using a more efficient irrigation system is not a solution to water shortages now experienced on project lands.

IMPACTS OF THE BOARD DENYING DFWP'S REQUESTED RESERVATIONS

Case 1. Existing Water Rights Constrain Future Development

The Board may choose to deny all of DFWP's requested reservations or deny those requested for individual streams or stream reaches. The impacts of denying instream flow reservations depend on how much water would be consumed in the future. If existing water rights limit future consumptive water uses, denying DFWP's reservations would not give DFWP legal standing to object to changes in water rights or applications for new nonconsumptive water use permits. Local fisheries, wildlife, water quality, and recreation may be degraded by such changes. Beneficial land use changes and tax benefits from such changes would not be curtailed.

Case 2. Existing Water Rights DO NOT Constrain Future Development

<u>Water Quantity Impacts</u>

DNRC analyzed irrigation development to assess the impacts of additional consumptive development, however, the same water could also be used for other purposes and have a similar effect. Irrigation development was chosen since this use accounts for over 85 percent of the water volume claimed and permitted in the upper basin (see Chapter Three).

Results of DNRC's analysis of how flows may change if all 8,362 acres of irrigable land are developed are presented in Table 3 in Appendix B. If DFWP's reservation requests were not granted and if water rights elsewhere in the basin did not limit additional consumptive uses, there would be enough water in the upper basin to provide full service irrigation to about 8,362 acres of irrigable land and still not fully deplete either the Clark Fork between Warm Springs and Bonner, or the Little Blackfoot River near the mouth. However, flows would be severely depleted in some cases and local water shortages might occur. For example, the Clark Fork is nearly dry above Deer Lodge in low-flow years now. Additional consumptive water uses could cause this situation to occur more frequently and for longer periods.

Table 5-7 shows predicted changes in average monthly flows below Milltown Dam and all points downstream from Milltown Dam after water is removed for sprinkler irrigation on an additional 8,362 acres. From October through January, delayed return flows of irrigation water would be expected to increase average flows by 0.3 to 7.9 cfs below the confluence of the Blackfoot River. From February through the end of April, flows would not be expected to

Table 5-7. Predicted change in flow due to an additional 8,362 acres of sprinkler irrigation.

Month	Change in flow (cfs)	Month	Change in flow (cfs)
October	+7.9	April	0
November	+3.7	May	-16.5
December	+1.4	June	-40.6
January	+0.3	July	-68.5
February	0	August	-49.1
March	0	September	- 8.0

change. During the irrigation season, May through September, average flows would decrease by as much as 68.5 cfs. Based on depletions that would occur from an additional 8,362 acres of irrigation, the predicted reductions in flow immediately below Milltown Dam would range from 0.4 to 2.9 percent of average flows during summer months. In low flow years, the predicted reductions in flows below Milltown Dam would range from 0.14 to 2.51 percent of flows during the summer.

Water Quality Impacts

If the Board does not grant DFWP's instream flow reservations, water will be available for additional consumptive use. If water consumption during the summer continues to increase on these streams, less water will be available to dilute incoming nutrients on the Clark Fork and may increase the frequency of low levels of dissolved oxygen. Issuing new permits for irrigation could compound the problem if newly cultivated and irrigated fields require the addition of nitrogen fertilizer; runoff or return flows would be more likely to contain elevated nitrogen levels. The combination of phosphorus and nitrogen supports undesirable algae growth. With the abundance of phosphorus in the upper Clark Fork, nitrogen is thought to be the limiting nutrient for algae growth in the upper river (Ingman 1988). Additional algae growth during the summer could result in depressed levels of dissolved oxygen.

Reduced flows also may increase stream temperatures on those reaches with little cool ground water inflow, further depressing dissolved oxygen levels. The combination, then, of reduced flows, increased nutrient loads, and increased algae growth may lead to more frequent violations of the state's dissolved oxygen standards.

If consumptive use of water increases in the winter, less water would be available from tributary streams to dilute metals during low winter flows in the Clark Fork. This would worsen existing water quality problems.

Fisheries Impacts

If no instream flow reservations are granted, then additional water could be available for consumptive water uses. Adverse impacts to fisheries could occur as a result of future consumptive water uses because DFWP would not have legal standing to object to new uses that would degrade aquatic habitat. It is not possible to predict the extent or timing of such development.

The impacts could be similar to, but more severe than impacts associated with reservations based on the lower inflection point. Lower flows in spawning tributaries could reduce the survival of young fish. Besides harming the fishery in a tributary, large reductions in the survival of young fish could affect fisheries in the Clark Fork, Warm Springs Creek, Flint Creek, and Georgetown Lake. Fish in these streams and in Georgetown Lake spawn in tributaries.

Reductions in flow that may occur without a reservation could significantly reduce habitat of fish with limited numbers or distributions such as bull trout and

westslope cutthroat trout. These species have limited distributions due to past fish stocking and habitat alteration.

Wildlife and Vegetation Impacts

Any major reductions in flow that would be allowed by not reserving instream flow would reduce habitat for water-dwelling mammals and waterfowl. Prolonged low flows could reduce the vigor of riparian vegetation. If fish populations are reduced, bald eagle use along the Clark Fork may decline.

Diversion of additional water for irrigation and other development could have both good and bad effects on vegetation and wildlife. Agricultural developments in riparian habitat or other important habitats would adversely affect wildlife. However, converting rangeland into irrigated cropland could benefit wildlife. Deer and waterfowl would find additional forage in these croplands.

Earth Resource Impacts

Denying reservations for instream flows would have no direct adverse effects on stream channel morphology.

Land Use Impacts

If the reservations requested by DFWP are not granted, any water available over and above existing valid water rights will be available for future appropriation. If these future appropriations are approved, it is possible that there will come a time when the upper basin water will become too heavily appropriated to support any sizable project. The lack of water, rather than the economic constraints that currently plague these projects, could effectively prevent the development of new irrigation. Also, the incidental benefits that would accrue to existing irrigators and municipalities as a result of instream flow reservations would gradually disappear as this water becomes appropriated.

Recreation Impacts

If existing water rights do not prevent the continued issuance of water-use permits, recreation resources would suffer as water is diverted. The magnitude of this impact would depend on the amount and timing of diversions. As water is diverted and recreation opportunities and settings degrade on the upper Clark Fork, it is possible that use would shift to other rivers and streams in the area. For Missoula area recreationists, other available rivers are the Blackfoot, Bitterroot, and lower Clark Fork. Where a river is currently heavily used, such as on the Blackfoot, any increased use could surpass the capacity of the resource to provide a quality recreational experience.

The recreational setting at Missoula's River Front Park would receive a small amount of protection if DFWP's requested reservations were granted. Denying the requested reservations would provide no additional protection. DFWP's claimed water rights on the Blackfoot River and Rock Creek could continue to contribute to existing flows in the Clark Fork below Milltown Dam, sustaining a low to moderate degree of protection if no additional depletions occur below Milltown.

Economic Impacts

The economic effects of granting no instream flow reservations are uncertain. In the absence of reservations, additional water could be available for irrigation. The availability of water would most likely benefit individual ranching operations able to implement small, economically viable irrigation projects, but would not have important impacts on the overall economy of the upper basin.

At substantially lower flows, Stone Container could be required to increase wastewater treatment. The mill's treatment system is expensive to operate and addtional treatment requirements would reduce the profitability of the mill (Henderson 1988). The timing of consumptive withdrawals and annual and seasonal flow conditions would influence costs to the mill. Stone Container is concerned that the cumulative depletions allowed by numerous future consumptive use permits could increase its wastewater treatment costs (Weeks 1988).

The extent of economic impacts on sightseeing, fishing, and boating would depend on whether flow reductions were significant enough to affect participation in these activities. At substantially lower flows, businesses catering to tourists and recreational users of the Clark Fork could be adversely affected.

Consumptive uses contributing to visible reductions in water quality or quantity could adversely affect Missoula area businesses that use their river front locations as part of their marketing programs. Substantially reduced flows could also deter new commercial investments from occurring along the river.

Substantial new consumptive uses of water could influence the production of power at the three hydroelectric generation plants located on the Clark Fork. Any additional consumptive uses are likely to reduce the amount of electricity produced at WWP's Noxon Rapids Dam. Effects on MPC's electricity production would depend on the timing of withdrawals and the characteristics of return flows.

Population Impacts

If future consumptive uses contribute to noticeable reductions in the Clark Fork's aesthetic qualities, they could discourage future residential development near the river and thus influence population distribution in the basin.

Taxation Impacts

In the absence of instream flow reservations, additional consumptive uses of Clark Fork water might eventually affect state, local government, and public school revenue collections. This would occur if new uses of water were to substantially increase or decrease the taxable value of real property, profitability of corporations, or personal income levels.

Expanded irrigation could increase the taxable value of some agricultural land in the basin. However, substantially reduced flows might contribute to the reduction in the taxable value of some other real property in the basin.

If additional water were available for any new industrial activities, both public property and income tax revenues could increase. However, major reductions in flows could also reduce state income tax collections from existing companies benefiting from existing flows, such as the Stone Container Corporation, WWP, and MPC.

Community Service Impacts

Substantially lower flows in the Clark Fork could increase the costs of wastewater treatment for residents of Missoula, Deer Lodge, and Anaconda. Lower flows could require DHES to adopt more stringent standards for the discharge of wastewater. In order to comply with more stringent standards, local governments could need to provide for more extensive sewage treatment, which would increase the costs of the public service.

If the Board denies DFWP's requested instream flow reservations, the nominal protection of recharge flows to the Missoula aquifer afforded by the reservations would not exist. The aquifer is tapped by wells operated by private water companies that serve Missoula residents. If new consumptive use permits continue to be issued, depletions in flow could reduce recharge to the aquifer and affect municipal water availability.

Community Development Impacts

Should future consumptive water uses contribute to noticeable reductions in water quantity or quality, they could adversely affect ongoing redevelopment activities along the Missoula river front. Noticeable deterioration of environmental qualities could reduce the value of existing public and private investments along the river and could serve to reduce the attractiveness of the area for future investment.

History and Archaeology Impacts

Denying instream flow reservations would result in the same potential impacts to historical and archaeological resources as DFWP's proposed reservations.

CHAPTER SIX

NEED AND PUBLIC INTEREST

This chapter summarizes the preceding analyses in terms of how DFWP's and GCD's reservation requests meet the criteria of being needed and in the public interest as required by the Administrative Rules of Montana (ARM).

NEED

The Board cannot grant a water reservation unless it finds that the reservation is needed. The Board's rules define a reservation as needed if "there is a reasonable likelihood that future instate or out-of-state competing water uses would consume, degrade, or otherwise affect the water available for the purpose of the reservation." (36.16.107B (2)(a) ARM)

DFWP

DNRC continues to issue new water use permits in the upper Clark Fork basin and cannot close a basin to further permits unless 10 or more water right holders petition for such closure. Up to this time, existing water right holders have not systematically objected to new applications or petitioned DNRC to close the basin. DFWP has objected to new permit applications in the upper Clark Fork, but DNRC has rejected these objections on the grounds that DFWP did not have standing to object because it did not have instream water rights that could be affected. If existing water rights do not constrain further consumptive development, and if DFWP is not granted a reservation, there is a reasonable likelihood that water currently available for fish and wildlife habitat and recreational use will be appropriated and put to other uses.

GCD

GCD is applying for a reservation of water for what it sees as the most promising potential irrigation project in its jurisdiction. If existing water rights do not constrain other development or water use, there is a reasonable likelihood that competing water uses would affect future water availability. DFWP has requested instream flows on Flint Creek and the Clark Fork which could conflict with GCD's requested reservation on the North Fork of Lower Willow Creek. Furthermore, irrigable lands have been identified on the Clark Fork that also may require flows from Lower Willow Creek.

PUBLIC INTEREST

The Board may not grant a reservation without finding that the reservation is in the public interest. This is to be done by weighing and balancing "(a) whether the expected benefits of applying the reserved water to beneficial use are reasonably likely to exceed the costs; (b) whether the net benefits associated with granting a reservation exceed the net benefits of not granting the reservation; (c) whether there are no reasonable alternatives to the proposed reservation that have greater net benefits; (d) whether failure to reserve the water will or is likely to result in an irretrievable loss of a natural resource or an

irretrievable loss of a resource development opportunity; and (e) whether there are no significant impacts to public health, welfare, and safety;" (36.16.107B(4) ARM).

DFWP

The benefits and costs of DFWP's proposed reservations depend on unknown future events and cannot be quantified precisely. The benefits would be higher if water quality improves as may happen due to cleanup of pollution sources such as EPA Superfund sites, or if recreational use increases on the upper Clark Fork and its tributaries. The costs of the reservations would be higher if there is a large future demand for water by other uses such as mining or industrial development.

Even if the future could be foreseen, there still would be uncertainty due to a lack of information about how various reductions in flows would affect fishing and other recreation on the river and its tributaries.

The unresolved questions about water rights in the upper Clark Fork basin also influence the benefits and costs of the reservation. If other actions prevent new appropriations, the reservation would have little additional impact, and its benefits and costs would be limited to the impact of DFWP objecting to water right changes.

Benefits

The reservations would benefit the citizens of Montana by preserving existing opportunities for recreation, waste dilution, and other uses of the river system. The reservations would not increase flows and would not prevent low flows in dry years, and would not increase opportunities for river use. The reservations would help protect the benefits from past and future investments to improve water quality and fisheries.

The value people place on fishing in the upper Clark Fork basin depends on the number, type, and size of fish they catch, the aesthetic qualities of the surroundings, the degree of crowding, the availability of other recreational opportunities, and the characteristics of potential users of the basin. Further depletions of flow in the upper Clark Fork and its tributaries may reduce fish populations and damage the aesthetic qualities of fishing sites.

Estimates based on travel costs indicate that current users value fishing in the upper Clark Fork basin at between $1.5 million and $3.1 million per year (Duffield and others 1987). If the reservation were not granted, any future water depletions in the upper basin could reduce the value of fishing. There have been no attempts to estimate the reduction in the value of fishing that would be caused by stream flow reductions in the Clark Fork basin.

If the proposed instream reservations prevent large additional depletions, they could provide benefits in the tens of millions of dollars over time. If the basin were closed to new permits, or if existing water rights constrain further depletions, the benefits of the reservations would be limited.

The effect of granting reservations on some streams but not on others would depend on which stream reaches were protected. Most streams where DFWP is requesting reservations are rated as substantial fisheries resources (MNRIS 1987). Some of the tributaries provide important spawning grounds, habitat for young fish, or habitat for fish populations with limited distribution. Dewatering of one of these streams would affect fishing in that stream and in other reaches that recruit fish from it.

If flows were substantially reduced in most or all of the tributaries, a large loss could result. For many users of the upper Clark Fork basin, substitute fishing opportunities outside the basin are much farther away. Opportunities for spur-of-the-moment and part-day trips made possible by nearby streams would be greatly reduced.

The value of boating on the Clark Fork has not been studied. Hagmann (1979) estimated that the upper Clark Fork basin is used by more than ten times as many anglers as boaters. If the value boaters place on a day on the Clark Fork is similar to the values found in studies of other

western streams, the value of present and future boating on the Clark Fork basin is at most a few million dollars.

If existing water rights prevent further depletions, DFWP's proposed reservation would have minimal benefits. If existing water rights do not prevent further depletions, DFWP's proposed reservation would be the primary force maintaining the value of boating on the Clark Fork. Granting DFWP less water than requested would have fewer benefits. Granting DFWP reservations at the lower inflection point would have minimal benefits because flows at this level would leave some river stretches impassable.

The Clark Fork and its tributaries provide a setting for various types of recreation, such as picnicking, cycling, and walking. No studies have estimated the value of these activities, nor of the importance of the Clark Fork to them.

People who do not use the upper Clark Fork basin in any given year may still place a value on the resource. People who do not actually use the river, but who might use it in the future, may place a value on the opportunity. Some people who never intend to personally use the upper Clark Fork basin for recreation may place a value on having high quality environmental resources available for others to use or for the sake of the resource itself.

These nonconsumptive values have not been estimated for the upper Clark Fork basin. However, the upper Clark Fork basin, where DFWP is requesting instream flows, does not have the unique qualities or the widespread recognition usually associated with resources that have a high value to non-users.

Communities and industries discharge treated liquid wastes into the upper Clark Fork and its tributaries. If the reservation were not granted, stream flows could be further depleted and new or changed water uses could lower water quality. If this happened, some or all of these dischargers might be forced to further clean up their effluent or stop discharging. The Department of Health and Environmental Sciences' future standards for sewage discharge will depend on the results of studies now under way. EPA regulations governing biological oxygen demand and chemical oxygen demand may also be changed in the future as a result of new studies. It is, therefore, impossible to give reliable estimates of the additional treatment costs that would be required by lower stream flows.

If existing water rights constrain future development, water available for junior appropriators would be significantly reduced. Therefore, the benefits of DFWP's reservations would be limited to preventing changes in water rights that would degrade fisheries or water quality. If flows in the main stem were greatly reduced, due to a change, industries and municipalities in the Clark Fork basin could be required to increase the treatment of their discharges. This could impose costs in the millions of dollars.

Costs

Granting DFWP the instream flow reservations would impose costs on other parties that may want to appropriate water from the Clark Fork or its tributaries for consumptive uses. DNRC's analysis of water availability shows that flows in excess of downstream hydropower use occur only in some years, and only during high flow periods in the spring of some years. New appropriations might therefore require dams to store high spring flows, with attendant costs. DFWP's requested reservations would have little additional impact.

If existing water rights do not limit future development, DFWP's reservations would be a primary impediment to new appropriations in the basin. The reservations would impose costs by making it more difficult for water to be put to new uses. Neither the enforcement of existing water rights nor DFWP's reservations would prevent new users from purchasing and transfering existing water rights. However, existing rights and DFWP's reservations might place limits on changes in location of diversion and type of use.

If existing water rights limit future development, or if the basin is closed to new

development, little if any water, other than spring runoff or from changes of other uses, would be available for new irrigation projects in the upper Clark Fork basin. DFWP's reservation requests would have little if any effect on new permits for irrigation development because DFWP is not asking to reserve high spring flows. In both cases, DFWP's reservations could limit changes of use to irrigation.

If existing water rights do not limit future development, DFWP's reservations would be the primary impediment to new irrigation development in the basin. DNRC refined the work of Elliot (1986) and identified 8,362 acres of irrigable land in the upper basin. DFWP's reservations would greatly limit, if not preclude, future irrigation development that did not rely on storage of high spring flows. Given foreseeable crop and cattle prices and production costs, irrigation projects requiring storage are unlikely to be economically feasible. Costs in this scenario could be as high as the tens of millions of dollars, but given the slim economic prospects for new development, costs are likely to be much lower.

If existing water rights limit the amount of water available for future development, DFWP's reservations would impose few if any costs on new industrial or mining water users. If existing water rights do not constrain future development, the reservations could impose costs by forcing new industrial plants or mines to buy existing water rights or build storage rather than making new, direct diversion appropriations.

In either case, new mines or industrial plants may be able to buy and change existing water rights, or may be able to appropriate groundwater. High-value industrial or mining water uses might be able to bid water away from agricultural uses. They also might justify the cost of storage projects.

It is not possible to reliably predict either the demand or the cost of water for industrial and mining uses. If the upper Clark Fork basin were the site of a mining boom in the near future, the DFWP reservations could impose costs of up to the tens of millions of dollars. If future mining and industrial development were more limited or occurred in the more distant future, the costs would be much lower.

If existing water rights limit future development, the reservations would impose negligible costs on municipalities. If existing water rights do not limit future development, the reservatious could prevent municipalities from diverting stream flows for future uses. But it would not prevent them from building storage projects and storing spring runoff or from appropriating groundwater from aquifers unconnected with the river. Municipalities are also allowed to obtain existing water rights through purchase or condemnation (Section 7-13-4405, MCA).

The extent of the above impacts would depend on population growth and the need of municipalities in the basin to obtain additional water. If water for an additional 10,000 people were needed in the near future, the reservation would impose costs of less than $1 million. The actual cost is likely to be much lower, because surface water requires treatment and future water quality standards will probably make surface water more expensive than ground water.

Montana law allows water rights to be bought and sold. However, approval is required from DNRC and, in some cases, from the Legislature for a change in the location of a diversion, the place of use, or the type of use. The approval process is similar to that for obtaining a water use permit and allows other water users to object. A water right change must not adversely affect the exercise of existing water rights (Section 85-2-402(2)(a), MCA). Granting DFWP's instream flow requests could impose costs on owners of water rights by reducing their opportunities to sell water or change its use. However, granting DFWP's requests would not absolutely prevent such changes. These benefits cannot be accurately quantified since the connection between flows and the values they support is unknown. Furthermore, the cost of preventing new uses or changes in existing uses is not known because these uses cannot be accurately predicted. It is impossible to estimate the cost that would result from this constraint on water right changes.

Comparison of Benefits and Costs

In sum, whether the benefits of granting DFWP's reservations would exceed the costs is unknown. Benefits would result primarily from preventing changes in existing uses or new uses which would adversely impact instream flows or water quality.

Alternatives

As stated above, benefits and costs of the reservations cannot be related to flow levels. It is therefore impossible to determine whether the net benefits of granting DFWP's reservation requests would be greater than the net benefits of granting reservations at a lower level.

DFWP repeatedly has objected to new water use permits in the upper Clark Fork basin. DNRC has rejected these objections on the grounds that DFWP does not have the legal standing to object. DFWP would acquire that standing if it were granted reservations and would join other existing water users in water rights proceedings. It is unclear whether water rights can be purchased and applied to instream use. Without reservations, DFWP may have no means to protect instream flows and fisheries.

Irretrievable Losses

If DFWP's reservation requests are not granted, and existing appropriations of water from the upper Clark Fork basin continue, or changes in existing water rights occur, DFWP would be unable to prevent further depletions of stream flows in the upper Clark Fork or its tributaries. This may result in the irretrievable loss, especially in tributaries of the Clark Fork, of fish species with limited numbers or distributions in Montana. These species include westslope cutthroat trout, bull trout, and shorthead sculpins. There also may be an irretrievable loss of spawning habitat and habitat for resident fish populations.

Public Health, Welfare, and Safety

There are no significant adverse impacts to public health, welfare, and safety associated with granting DFWP's reservation requests.

GCD

Benefits

The North Fork of Lower Willow Creek project would provide supplemental irrigation water for 2,900 acres currently served by the existing reservoir on Lower Willow Creek. There would be no change in the type of land use, but hay yields would increase because of more frequent availability of irrigation water in the late summer.

The project would have indirect benefits due to the recreation opportunities afforded by higher and more stable water levels in the existing reservoir on Lower Willow Creek. The project would increase flows in Lower Willow Creek, Flint Creek, and the Clark Fork in the late summer and fall. There would be no measurable secondary economic benefits.

Costs

DNRC estimates the project costs (Appendix E) to be a minimum of $9.97 million. This is over three times GCD's estimate of $2.9 million. The major disparities are in the costs of the spillway and outlet works.

Indirect costs of the project would include possible degradation of the fish habitat in the stream reach between the proposed and existing reservoirs, flooding of wildlife habitat and irrigated land at the reservoir site, and the preclusion of other uses of the water consumed by the project. The water diverted by the project would reduce power production from the three hydroelectric plants on the Clark Fork in Montana, although delayed return flows would slightly increase production. The net effect would be a reduction of 138,000 kilowatt-hours in a typical year. This is an annual cost of $3,000 at current wholesale power rates. The project would cause a net reduction of power production at Columbia River hydroelectric plants downstream from Montana by 2,000,000 kilowatt-hours in a typical year. This is an annual cost of $52,000 at current wholesale power rates.

Comparison of Benefits and Costs

The project could be profitable for the participants if federal or state subsidies were

available. However, such subsidies probably will not be available, and it is highly unlikely that the project would pay for itself. DNRC's estimate of direct project costs is over three times the district's estimate of $2.9 million. Project benefits would be greater than DNRC's cost estimate only if the project increased annual returns above production costs by an average of $161 per acre, net of crop production costs. GCD's estimated costs would require a net annual increase of $45 per acre. DNRC computed project feasibility for 300 different combinations of crop prices and yields, production costs, and stream flows. Crop price forecasts were based on 38 years of historic alfalfa and grain prices. Alfalfa yields were based on consumptive water use and growth functions. Average yield was estimated to be approximately 2.5 tons per acre and peak yield was estimated to be approximately 3.1 tons per acre (Dodds 1988). The increase in water supply from the proposed project was used to estimate the increase in crop yields associated with project development. A direct relationship was assumed between alfalfa yields and water availability. The project was not found to be economically feasible under any of the 300 situations modeled, regardless of the dam cost estimates used.

A reservation would give GCD an earlier priority date than it would have if it obtained a permit at a later construction date. Granting GCD's reservation would impose costs on future water users that might wish to appropriate the same water. Junior appropriators would risk losing the use of water allocated to GCD's reservation if the project is constructed. However, it is unlikely that the reservation would preclude new uses because the project is located in a remote basin where other uses are not likely to occur. Thus, the costs of granting GCD's reservation or the benefits of not granting the reservation are also small.

If no water is available because of downstream rights, the reservation could not be fully used without interfering with existing rights. Granting the reservation would have no benefits and no costs.

Alternatives

The project lands might be served by using water stored in the Georgetown/Silver Lake system which may be for sale. A new canal might be constructed beginning just below Maxville and running to just above the northside canal. Preliminary cost estimates based on a 21.6-mile long canal capable of handling 150 cfs showed the canal might be constructed for $4.8 million. The actual canal capacity required for this option may be considerably smaller. This does not include the costs for diversion works in Flint Creek, costs of acquiring water rights and operating the storage projects, or environmental costs. Environmental costs might include fluctuations in the level of Georgetown and Silver lakes, further flow reductions in Warm Springs Creek and tributaries, and possible erosion of stream banks in Flint Creek. However, preliminary cost estimates show this option to be more feasible than GCD's proposed dam on the North Fork of Lower Willow Creek. This alternative would also be infeasible based on DNRC's analysis of project returns.

Decreasing the size of the proposed reservoir also was considered. The cost per acre foot of storage would be higher for a smaller reservoir. Therefore, a smaller reservoir would be less feasible than GCD's proposal.

Irretrievable Losses

Not granting the reservation would expose the district to the risk that another party might appropriate the water needed for the project. This would increase the cost of the project by forcing the district to purchase and change existing water rights, but would not prevent the project from being constructed. These purchases may make the project even less feasible.

Public Health, Welfare, and Safety

The primary impacts of this project on public health and safety would come from dust, noise, and increased sediment in the stream during construction. Because of the project's remote location, few if any people would be exposed to these impacts. All of these impacts could be reduced by appropriate mitigation measures. Proper construction techniques would be required to minimize the risk of failure of the proposed high hazard dam.

CHAPTER SEVEN

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This chapter discusses water, land, and other resources that could be irreversibly or irretrievably committed to use if reservations are granted.

DFWP

Water

Water reserved for instream use is not necessarily permanently unavailable for other uses. The Board may reallocate part or all of an instream flow reservation to another qualified reservant if the Board finds that the water is not required for its original purpose and that the need for the new use outweighs the need for the original reservation. The Board also may revoke or modify the reservation if the reservation is later found to exceed the flows necessary to meet the purpose of the reservation. In turn, this revoked water becomes available for future appropriations.

Land

No land would be irreversibly or irretrievably committed as a result of reservations for instream purposes. Instream reservations would preclude conversion of rangeland to irrigated cropland or pasture, if such conversion were not prevented by other factors.

Energy and Materials

No energy or material resources would be irreversibly or irretrievably committed if DFWP's reservation requests are granted.

Aquatic Communities

Instream flow reservations would help protect habitat for organisms living in the streams.

Other

Granting DFWP instream flow reservations would not irreversibly or irretrievably commit wildlife, recreation, or aesthetic resources or change water quality supported by the present drainage system.

GCD

Water

Granting GCD its requested reservation would commit water for future irrigation. Committing this water to GCD for irrigation may preclude future uses of the water. However, provisions in the Water Use Act require the Board to review reservations at least every 10 years. If objectives of the reservation are not being met, the Board may extend, modify, or revoke the reservation in the future.

Land

For the North Fork of Lower Willow Creek project, about 112 acres of flood-irrigated pasture and meadow would be inundated by the reservoir. An undetermined amount of land would be excavated for material to construct the dam.

Energy and Materials

Energy and materials committed to irrigation development could not be retrieved. Consumptive use of the reserved water would result in a loss of 138,000 kwh for hydropower generation in Montana valued at $3,000 per year and 2,000,000 kwh for Montana and the Northwest region valued at $52,000 per year.

Aquatic Communities

Possible adverse impacts to westslope cutthroat trout in the North Fork of Lower Willow Creek due to reduced flows are reversible only if water would be returned to the stream. However, the existing trout population may be irretrievably lost if adequate releases are not made from the proposed dam. Whether or not this loss occurs depends on the final operating plan adopted by GCD.

Other

Temperature changes in the water below the proposed reservoir are reversible only if water is no longer stored at the proposed dam.

CHAPTER EIGHT

OPTIONS, TRADEOFFS, AND DECISIONS

This draft EIS provides information regarding the environmental impacts and economics of the proposed reservations and alternatives to them. The Board will use the information provided in this draft EIS, comments and responses presented in the final EIS, as well as testimony presented in any contested case hearing to decide whether to grant all or part of the requested reservations, or to deny one or both of the reservation requests altogether.

The Board decision must be consistent with the Water Use Act, the Montana Environmental Policy Act, and the administrative rules in effect at the time of the decision. In general, the Water Use Act requires applicants to establish to the Board's satisfaction the purpose of the reservation, the need for the reservation, the amount of water required for the reservation, and that the reservation is in the public interest. The Board's administrative rules require the Board to weigh and balance the following factors in making its determination:

1. That there is a need for the reservation because of a reasonable chance for competition from other future water users who would consume or degrade water requested in the reservation, the applicant demonstrates the importance of reserving water, or the applicant is constrained from using a water permit instead of a reservation.

2. That the methods and assumptions used to determine the requested amount of water are reasonable, accurate, and suitable, including water use efficiencies associated with diversion. In the case of GCD, the Board also must find there would be no reasonable cost-effective measures to increase use efficiency which would lessen the amount of water required for the purpose of the reservation.

3. Whether the expected benefits of applying the reserved water to beneficial use are reasonably likely to exceed costs, considering all direct and indirect costs and benefits to the applicant and to the state.

4. Whether the net benefits associated with granting a reservation exceed the net benefits of not granting the reservation.

5. If there are reasonable alternatives to the proposed reservation.

6. Whether failure to reserve the water will or is likely to result in an irretrievable loss of a natural resource or an irretrievable loss of a resource development opportunity.

7. Whether there are significant adverse impacts to public health, welfare, and safety.

8. Any other factors the Board finds relevant, based on the record.

9. The Board must find that reservations, as conditioned by the Board, would not adversely affect existing water rights including other reservations.

The issues discussed in this draft EIS that pertain to the Board's decision criteria are summarized in Table 8-1.

In addition to the information in Table 8-1, issues relating to social and environmental impacts are discussed in Chapter Five and summarized in Table 8-2.

In evaluating the merits of the various options, the Board must weigh uncertainties against the known advantages and disadvantages of the options discussed in this EIS. These uncertainties include questions about future water availability, poorly understood relationships between flows, fish populations and resulting recreational benefits, and future improvements in water quality.

The Board must choose one of the following options:

1. Approve the reservations as proposed.

2. Approve the reservations as applied for with whatever conditions the Board may find necessary to avoid or reduce environmental impacts.

3. Because GCD's and DFWP's applications compete for some of the same water, the Board, by granting one request before the other, may give one applicant priority over the other.

4. Approve reservations for less than the full amount of water on all or some of the streams where reservations are requested.

5. Deny all or part of the reservation applications on the grounds: (1) that they are not needed; (2) that the amount requested is not appropriate; (3) that the reservations are not in the public interest; (4) that the reservations would interfere with existing water rights; (5) that the applicant is not able to secure financing for projects associated with the requested reservations, or does not have the capability to measure, quantify, protect, and report instream uses according to the applicant's management plan; or (6) of other relevant factors.

Table 8-3 summarizes the advantages and disadvantages of each of these options.

Table 8-1. Board Decision Criteria.

ISSUE	DFWP CASE 1: Other claims and permits limit new uses.	DFWP CASE 2: New consumptive uses are not limited by existing claims and permits.
Need	Changes in existing water rights might adversely affect the flows requested.	New use permits and changes in existing water rights might adversely affect the flows requested.
Amount	The method of estimating flow requirements for aquatic habitat is reasonable, accurate, and suitable as a general indicator of aquatic habitat needs. However, the requests for Clark Fork Reaches 1 and 2, Warm Springs Creek, and a portion of Flint Creek, Reach 1 exceed 50 percent of the average annual flow recorded.	The method of estimating flow requirements for aquatic habitat is reasonable, accurate, and suitable as a general indicator of aquatic habitat needs. However, the requests for Clark Fork Reaches 1 and 2, Warm Springs Creek, and a portion of Flint Creek, Reach 1, exceed 50 percent of the average annual flow recorded.
Public Interest		
a) Benefits and costs of applying the reserved water to beneficial use.	It is uncertain whether the benefits would exceed the costs. Relationships between stream flows and benefits have not been quantified. The cost of preventing the changes would depend on future events that cannot be known in advance.	It is uncertain whether the benefits would exceed the costs. Substantial benefits are likely to occur from preserving instream flows in the upper basin. However, the cost of preventing new uses and changes in current uses is unknown.
b) Net benefits associated with granting versus the net benefits of not granting the reservations.	b) For the same reasons stated in (a), it is not known whether the net benefits of granting the reservations will exceed the net benefits of not granting the reservations.	b) Again, it is not known whether the net benefits of granting the reservation would exceed the net benefits of not granting the reservation.
c) Alternatives	c) There are reasonable alternatives to granting DFWP's requests. Granting a lesser amount would give DFWP legal standing to object to changes in water uses. However, as in (a) and (b), it is not known whether the benefits would exceed the cost of preventing these changes.	c) There are reasonable alternatives to granting DFWP's requests. Granting a lesser amount would give DFWP legal standing to object to new permits and changes in existing uses. However, as in (a) and (b), it is not known whether the benefits would exceed the costs.

d) Irretrievable loss	d) There is a possibility that by not granting the reservations, a stream or stream reach could be depleted, causing irretrievable damage to fish populations of special concern. This is especially true in tributary streams.	d) There is a possibility that a stream reach could be depleted if the reservations are not granted, causing irretrievable damage to fish populations of special concern. This is especially true in tributary streams.
e) Public health, welfare, and safety	e) There are no significant adverse affects to public health, welfare, and safety.	e) There is no significant adverse impacts to public health, welfare, and safety.
Current water right claims and permits	Granting DFWP's requests would not adversely affect existing water rights.	Granting DFWP's requests would not adversely affect existing water rights.
Future water use permits and changes	DFWP would gain the legal standing to object to changes in water rights where the proposed change could adversely affect instream flows.	DFWP would gain the legal standing to object to the issuance of new use permits and changes in existing water rights where the proposed use would adversely affect instream flows.

GCD

	CASE 1: Other claims and permits limit new uses.	**CASE 2: New consumptive uses are not limited by existing claims and permits.**
Need	Existing water rights would preclude development of the proposed project.	New uses could further limit water availability for the proposed project.
Amount	GCD's methods and assumptions were reasonable, accurate and suitable, except for consideration of downstream water rights. There are no cost-effective measures that could be taken to increase use efficiencies which have been identified.	GCD's methods and assumptions were reasonable, accurate and suitable, except for consideration of downstream water rights. There are no cost-effective measures that could be taken to increase use efficiencies which have been identified.
Public Interest		
a) Benefits and costs of applying the reserved water to beneficial use.	a) The benefits are extremely unlikely to exceed the costs of using the reserved water. At best, water would be available to meet all project needs less than 5 years out of 10.	a) The benefits are very unlikely to exceed the costs of using the reserved water.

b) Net benefits associated with granting versus the net benefits of not granting the reservation.	b) The net benefits of granting or denying the reservation are essentially zero since downstream rights virtually prohibit any development.	b) The net benefit of granting the reservation is the difference between the value of the priority date to GCD and the risk it would impose on others who may want to appropriate water during the term of the reservation. Both of these are small, and it is uncertain which is larger. The net benefits of denying the reservation are unknown.
c) Alternatives	c) There is at least one alternative, using water from Georgetown Lake, which might have greater net benefits than GCD's proposal.	c) There is at least one alternative, using water from Georgetown Lake, which might have greater net benefits than GCD's proposal.
d) Irretrievable loss	d) There is no irretrievable loss of a resource development opportunity if the reservation is not granted.	d) There is no irretrievable loss of a resource development opportunity if the reservation is not granted.
e) Public health, welfare, and safety	e) The proposed dam would be classified as high hazard. Therefore, proper construction techniques will be required to prevent the project from endangering public health, welfare, and safety.	e) The proposed dam would be classified as high hazard. Therefore, proper construction techniques will be required to prevent the project from endangering public health, welfare, and safety.
Current water right claims and permits	The proposed use may adversely affect existing water uses. GCD's analysis did not take into account existing water rights downstream of the project, including uses on Lower Willow Creek and hydropower facilities in the basin.	Even if new consumptive uses are not constrained by hydropower water rights, claims and permits on Lower Willow Creek could conflict with project development. Therefore, the proposed use might adversely affect existing water uses.
Future water use permits and changes	The amount of water available below the reservoir would be reduced if the proposed dam is constructed. This in turn would reduce the water available for other future uses.	The amount of water available below the reservoir would be reduced if the proposed dam is constructed. This in turn would reduce the water available for other future uses.

Table 8-2. Summary of Impacts Associated with Proposed Reservations

DFWP

Option 1: Grant reservations
Option 2: Grant reservations with any conditions the Board may find necessary to reduce impacts
Option 3: Grant both reservations, but give DFWP priority GCD[a]
Option 4: Grant small reservations, based on lower inflection point
Option 5: Deny reservations

	Options 1, 2, and 3	Option 4	Option 5
Future water availability			
Case 1	low adverse	low adverse	none
Case 2	high adverse	moderate adverse	none
Protection of water quality			
Case 1	low beneficial	low beneficial	low adverse
Case 2	high beneficial	moderate beneficial	moderate-high adverse
Protection of fish and aquatic habitat			
Case 1	low beneficial	low beneficial	low adverse
Case 2	high beneficial	moderate beneficial	moderate-high adverse
Protection of riparian vegetation and riparian wildlife habitat			
Case 1	low beneficial	low beneficial	low adverse
Case 2	low-moderate beneficial	low-moderate beneficial	low-moderate adverse
Potential addition of wildlife foraging areas			
Case 1	low adverse	low adverse	low beneficial
Case 2	low-moderate adverse	low-moderate adverse	low-moderate adverse
Protection of recreational resources			
Case 1	low beneficial	low beneficial	low adverse
Case 2	high beneficial	moderate beneficial	moderate-high adverse
Protection of earth resources			
Case 1	none-low beneficial	none-low beneficial	none
Case 2	low beneficial	low beneficial	none
Land use impacts to existing irrigators			
Case 1	none-low beneficial	none	none
Case 2	moderate beneficial	low beneficial	none
Future development of irrigation			
Case 1	low adverse	none-low adverse	none
Case 2	high adverse	moderate adverse	none
Economic Impacts			
Wood products manufacturing			
Case 1	none	none	none
Case 2	none-low beneficial	none-low beneficial	potential none-low adverse
Hydropower production			
Case 1	none	none	none
Case 2	low beneficial	low beneficial	low adverse

Travel and recreation industry			
Case 1	none	none	none
Case 2	none-low beneficial	none-low beneficial	none-low adverse
Protection of investments in Missoula Riverfront area			
Case 1	none	none	none
Case 2	low-none beneficial	low-none beneficial	low-none adverse
Population impacts			
Case 1	none	none	none
Case 2	low	low	low

<u>Public Service Impacts</u>

Wastewater treatment			
Case 1	none	none	none
Case 2	low-moderate beneficial	low beneficial	low-moderate adverse
Tax base			
Case 1	none	none	none
Case 2	low adverse	low adverse	low beneficial
Protection of historical and archaeological resources			
Case 1	none	none	none
Case 2	none-low adverse	none-low adverse	none

GCD

Option 1: Grant reservations

Option 2: Grant reservations with any conditions the Board may find necessary to reduce impacts

Option 3: Grant both reservations but give one applicant priority over another[b]

Option 4: Grant smaller reservations than requested

Option 5: Deny reservations

	Options 1, 2, and 3[c]	Option 4[d]	Option 5
Future water availability			
Case 1	none	----	none
Case 2	high beneficial	----	none
Protection of water quality			
Case 1	none	----	none
Case 2	low-moderate adverse	----	none
Protection of fish and aquatic habitat			
Case 1	none	----	none
Case 2	low-high adverse[e]	----	low-high beneficial
Protection of riparian vegetation and riparian wildlife habitat			
Case 1	none	----	none
Case 2	low adverse	----	none
Creation of waterfowl habitat			
Case 1	none	----	none
Case 2	low beneficial	----	none
Protection or improvement of recreational resources			
Case 1	none	----	none
Case 2	low-moderate beneficial	----	none
Protection of earth resources			
Case 1	none	----	none
Case 2	low-high adverse	----	none
Land use impacts to existing irrigators			
Case 1	none	----	none
Case 2	none	----	none
Future development of supplemental irrigation			
Case 1	none	----	none
Case 2	moderate-high beneficial	----	moderate-high adverse
Economic Impacts			
Wood products manufacturing			
Case 1	none	----	none
Case 2	none	----	none
Agriculture			
Case 1	none	----	none
Case 2	moderate adverse[f]	----	none
Hydropower production			
Case 1	none	----	none
Case 2	low-moderate adverse	----	none

Travel and recreation industry			
Case 1	none	----	none
Case 2	none	----	none
Protection of investments in Missoula Riverfront area			
Case 1	none	----	none
Case 2	none	----	none
Population impacts			
Case 1	none	----	none
Case 2	none	----	none
Public Service Impacts			
Wastewater treatment			
Case 1	none	----	none
Case 2	none-low beneficial	----	none-low adverse
Tax base			
Case 1	none	----	none
Case 2	none-low beneficial	----	none
Protection of historical and archaeological resources			
Case 1	none	----	none
Case 2	low adverse	----	none

[a] Assumes DFWP's reservations have priority over GCD's.
[b] Assumes GCD's reservation has priority over DFWP's.
[c] If existing claims and permits constrain development, it is assumed GCD's proposed project could not be built.
[d] A smaller sized dam will be less financially viable than would the proposed dam.
[e] Impacts could be high if the operating plan does not contain provisions for adequate instream flows for fish or if flows are allowed to fluctuate substantially.
[f] Assuming the project is not subsidized, the economic well being of local ranches may be adversely affected.

Table 8-3. Advantages and Disadvantages of Board Options.

	DFWP		
	Options 1, 2 and 3	Option 4	Option 5
	Approve Proposed Reservations, Possibly with Conditions to Reduce Environmental Impacts	Approve Reservations for Less Than the Full Amount of Water on All or Some Streams	Deny Proposed Reservations
ADVANTAGES	- gives DFWP legal standing to object to new permits and future changes in water rights	- gives DFWP legal standing to object to new permits and future changes in water rights	
	- preserves instream flows, protecting existing aquatic habitat, water quality, recreation, and riparian habitat	- allows some protection to aquatic habitat, water quality, recreational resources, and riparian habitat, although at a lower level	- allows any unappropriated flow to be used consumptively by new irrigators, industries, mining operations, or other consumptive water users
	- protects investments being made in cleanup of Clark Fork	- provides a lower level of protection for investments made in Clark Fork cleanup	- does not interfere with GCD's requested reservation
	- in the practical sense, it provides a small amount of protection to the city of Missoula and Stone Container from the cumulative effects of dewatering in the future	- provides a slightly lower level of protection to the city of Missoula and Stone Container future dewatering	
	- allows unappropriated high spring flows to be stored	- allows unappropriated high spring flows to be stored. May allow additional irrigation in the future	
	- provides existing water users a degree of protection from future applications for water use permits	- provides existing water users a degree of protection from future applications for water use permits	
	- Board's decision is reversible	- Board's decision is reversible	

	Options 1, 2, and 3	Option 4	Option 5
	Approve Proposed Reservations, Possibly with Conditions to Reduce Environmental Impacts	Approve Reservations for Less Than the Full Amount of Water on All or Some Streams	Deny Proposed Reservations
DISADVANTAGES	- precludes future full service irrigation in the Clark Fork basin above Rock Creek if existing water right claims and permits do not do so already - may make changes in water rights more difficult in the future - interferes with GCD's requested reservation in the Lower Willow Creek drainage - precludes future consumptive water uses on tributaries from January 1 to April 30; greatly reduces the amount of water available for consumptive use from May 1 to January 1	- provides less protection for instream flows, aquatic habitat, vegetation, and wildlife than requested reservations - precludes future full service irrigation in the Clark Fork above Rock Creek if water right claims and permits do not do so already - may make changes in water rights more difficult in the future - reduces the amount of water available for consumptive use year round	- provides no protection for fish, wildlife, and recreational resources, water quality, and riparian vegetation - does not protect the investment being made in pollution cleanup in the upper Clark Fork - provides no protection to municipalities and industries who depend on the river and tributaries for dilution of waste water

GCD

	Options 1, 2, and 3	Option 4	Option 5
	Grant Reservation that Would Not Interfere with Water Rights on Lower Willow Creek and/or Include Conditions to Avoid or Reduce Environmental Impacts	Grant a Smaller Reservation	Deny Proposed Reservation
ADVANTAGES	- allows unallocated water to be set aside for a future dam allowing supplemental irrigation - if used, increases productivity on 2,900 acres of existing irrigable land - if subsidized, the proposed project could provide supplemental income to local businesses and farm and ranch families - would help maintain more stable water levels in the existing reservoir - would help maintain flows in Flint Creek Reach 2 in low flow years	- a reservation smaller than that requested is unlikely to be used because a smaller dam is more costly for its size and probably would not pay for itself	- would not tie up unallocated water which may be used by other appropriators with more feasible projects - would not harm the fishery below the proposed dam

GCD

	Options 1, 2, and 3	Option 4	Option 5
	Grant Reservation that Would Not Interfere with Water Rights on Lower Willow Creek and/or Include Conditions to Avoid or Reduce Environmental Impacts	Grant a Smaller Reservation	Deny Proposed Reservation
DISADVANTAGES	- would decrease hydropower generation in western Montana and the region - unless conditions are placed on operating plan to provide flows below the proposed dam, may cause irretrievable losses of westslope cutthroat trout below proposed dam - project is not likely to pay for itself - if supplemental government funding is not available, may decrease income of local farms and ranches - conflicts with DFWP's request on Flint Creek Reach 2 during 2 months of the year on average	- a reservation smaller than that requested is unlikely to be used because a smaller dam is more costly for its size and probably would not pay for itself	- GCD may lose priority date and water may not be available for the proposed project in the future - water shortages will continue to occur on 2,900 acres of existing land

DNRC'S RECOMMENDATIONS

The decision whether to grant a water reservation is made solely by the Board. DNRC assists the Board by providing information on each proposed reservation. Following the hearing on the proposed reservations, DNRC also will make a recommendation to the Board concerning each reservation request. DNRC's preliminary recommendations are included here to inform the public of the department's present position on the reservations requested by DFWP and GCD, and to provide an opportunity for public comment. DNRC's recommendations on DFWP's and GCD's reservations will not be finalized until after the board hearing.

The known environmental impacts of GCD's proposed project are expected to be minor and, in most cases, can be mitigated. However, DNRC's analysis indicates that the costs of building the dam and reservoir are greater than the anticipated supplemental irrigation benefits. Under present conditions, the proposed project appears to be economically infeasible, and is not likely to become feasible in the foreseeable future. It also is unlikely that financing could be secured to subsidize the proposed project construction. Since the benefits of the project do not currently outweigh the costs, the proposed project does not meet one of the factors used to weigh whether the reservation is in the public interest.

However, GCD contends that "when the economy is stronger the proposed project will be constructed" (GCD 1986). GCD's request is the only off-stream use being sought in this reservation proceeding. Further, granting DFWP's instream flow request would essentially preclude future off-stream use of most water currently available for appropriation, except in high spring flows. Therefore, DNRC recommends that the Board consider one of the following two positions: (1) the Board grant GCD's request with the condition that construction must begin by 2002, the year proposed by GCD in its application (GCD 1986). If GCD does not begin construction by this time, the reservation would be automatically revoked; or (2) the board deny GCD's application but subordinate DFWP's reservation to some level of future consumptive development. This would allow the development of GCD's proposed project or other potential projects in the basin. The specific amount of water involved and where that development could occur would be defined in the Board order granting DFWP's reservation.

If the GCD request is granted, the Board should also require that a second environmental analysis be prepared prior to construction, focusing on the impacts of dam construction in the Lower Willow Creek drainage. If significant impacts are identified, a second environmental impact statement should be required.

A recommendation concerning DFWP's reservation requests will be made by DNRC either in the final EIS or as a separate document submitted to the Board. In DNRC's opinion, DFWP has shown that its requested reservations are needed and in the public interest. However, DNRC has not yet developed a recommendation regarding the amount of water needed to meet the purpose of the reservations. Two underlying concerns have yet to be resolved:

1. How much water is available for appropriation in the Clark Fork basin; and

2. Whether to grant a lesser amount than the flows requested by DFWP, or to subordinate the instream reservations to consumptive uses in the Clark Fork basin.

GLOSSARY

Acre-foot (af)
: a unit commonly used for measuring a volume of water; the volume required to cover 1 acre to the depth of 1 foot, and equal to 43,560 cubic feet or 325,851 gallons

Average annual flow
: the average volume of water passing a given point during a year

Basic industry
: those producers of goods and services that support most of the employment and monetary circulation in a given economy

Biological Oxygen Demand (BOD)
: a measure of the oxygen used in meeting the metabolic needs of aerobic microorganisms in water rich in organic matter; also called biochemical oxygen demand

Biomass
: mass of life forms, often applied to one or more species in a particular area

Chemical Oxygen Demand
: a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water

Cubic feet per second (cfs)
: a rate of discharge (flow). One cubic foot per second is equal to the discharge of a stream having a cross-section area of 1 square foot and flowing at an average velocity of 1 foot per second

Dissolved oxygen
: molecular oxygen in solution

Eightieth (80th) percentile flow
: that low flow which is equaled or exceeded in 8 of every 10 years, on the average

Eutrophication
in a body of water, the process of nutrient enrichment that leads to increased aquatic plant growth and fluctuations in dissolved oxygen levels

Full service irrigation
an irrigation system capable of supplying sufficient water to a crop over the full growing season for optimum growth

Hard water
water with a substantial amount of dissolved minerals, usually calcium and magnesium

Nonconsumptive use
water use which does not require the removal of water from its natural channel or if removed, a water use that does not result in decreased stream flow, such as hydropower production; examples also include fish and wildlife and recreation

Non-point pollution
pollution from a widespread area, as opposed to pollution that occurs from an identifiable site

pH
a measure of acidity or alkalinity

Present worth
also known as present value or discounted value. The value today of a sum of money that will be earned or paid in the future. To obtain a present value, an interest rate is used to discount these future earnings or payments.

Priority date
the date when claimed water was first put to beneficial use or the date when an application for a water-use permit was received by DNRC

Reservation
a water appropriation for existing or future beneficial uses approved by the Board

Riffle
a shallow rapid in a stream

Riparian
pertaining to the banks of streams or lakes

Simulation
in computer modeling, imitating the probable behavior of a real or hypothetical prototype

Soft water
water with a very small amount of dissolved minerals or containing dissolved carbon dioxide or acids

Superfund site

a hazardous waste cleanup site designated by the United States Environmental Protection Agency under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

TSS - Total Suspended Solids

all of the sediment and organisms suspended in a stream or that contribute to turbidity in still waters

Turbidity

opaqueness or reduced clarity of a fluid, due to the presence of suspended matter

Spawning

laying of eggs; especially applied to fish

Water right change

a legal change in the place of use, point of diversion, and/or type of use associated with an existing water right

APPENDIX A

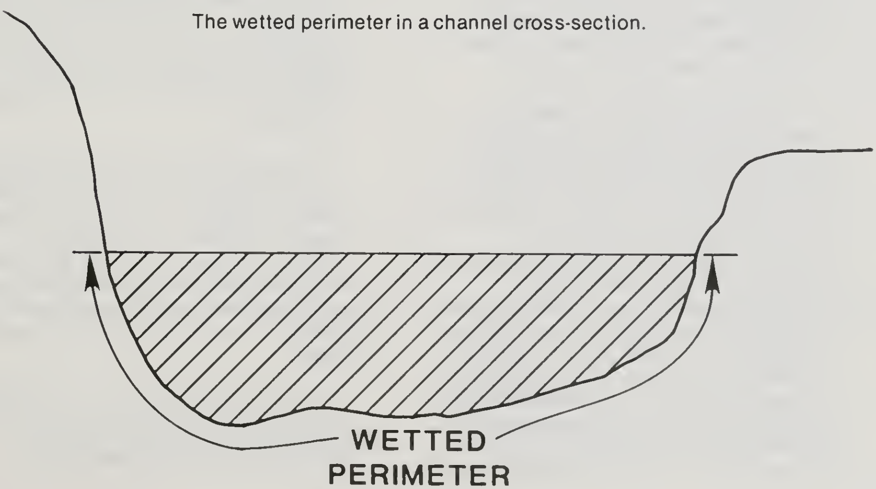
DISCUSSION OF DFWP'S WETTED PERIMETER METHODOLOGY

DFWP requested instream flows in the Clark Fork and its tributaries for two primary purposes--protection of aquatic habitat, and continuation of adequate flow to dilute pollutants in the Clark Fork. In determining the amount of instream flow necessary to protect habitat in riffle areas, DFWP used the Wetted Perimeter Inflection Point (WETP) method of calculation. This method assumes that aquatic organisms making up the majority of food for trout and whitefish are produced in riffle areas, and that food supply for the fish is a major factor in determining a stream's carrying capacity. Carrying capacity relates to the number of fish or pounds of fish a stream can support. The WETP method assumes the number of game fish, such as trout and whitefish, that can be produced in a stream is proportional to the wetted perimeter in riffle areas.

Wetted perimeter is the linear distance along the bottom and sides of a stream that is in contact with water when the stream is viewed in cross section (see Figure A-1). As flows change, the wetted perimeter of a stream changes.

FIGURE A-1

The wetted perimeter in a channel cross-section.



When stream flow is plotted against wetted perimeter, it can be seen that this rate of change is not constant (see Figure A-2). At higher flows, the wetted perimeter of a riffle will not change much as flow changes. As flows decrease, the wetted perimeter decreases more dramatically. As flows are reduced to very low levels, the wetted perimeter decreases very quickly. When examining wetted perimeter versus flow graphs, there are points called inflection points where the rate of change in wetted perimeter is abrupt.

At high flows, the channel is full and, except for floods, the stream has reached its maximum width. As flows are reduced, the wetted perimeter does not change much until the upper inflection point is reached. At the upper inflection point, water is beginning to drop below the vertical portion of stream banks and the rate of change in wetted perimeter begins to increase. As flows are reduced further, the stream bottom begins to be dewatered. Below a certain flow, the wetted perimeter decreases quickly. The point where the stream bottom (roughly horizontal portion of the channel) begins to be dewatered is the lower inflection point. The upper and lower inflection points vary from one stream to another and within a single stream the upper and lower inflection points will vary from one study cross section to another. Figures A-3 and A-4 compare wetted perimeter-flow curves at several riffles in two reaches of the Clark Fork. DFWP averages the wetted perimeter-flow curves from several riffle cross-sections when determining inflection points.

According to DFWP, "the Wetted Perimeter Inflection Point Method provides a range of flows (between and including the lower and upper inflection points) from which a single instream flow recommendation is selected. Flows below the lower inflection point are judged undesirable based on their probable impacts on food production, bank cover, and spawning and rearing habitats, while flows at and above the upper inflection point are considered to provide near optimal conditions for fish. The upper and lower inflection points are believed to bracket those flows needed to maintain high and low levels of aquatic habitat potential." (Montana DFWP 1986b)

The shape of the wetted perimeter versus flow curve depends on the shape of the channel. Wide-shallow stream channels will have gently sloping wetted perimeter curves while a channel with steep banks will show abrupt changes in the shape of the wetted perimeter versus flow curve. Determining upper and lower inflection points can be somewhat subjective, especially when the slope of the wetted perimeter versus flow curve does not change dramatically.

Within the range of flows between the upper and lower inflection points, DFWP biologists use professional judgment to estimate the instream flow needed to sustain the fish species present, the quality of habitat, recreational use, and potential for stream reclamation and eventual increases in fisheries production.

In reviewing the WETP method DFWP used, several concerns have been raised. The first is that DFWP relied on the professional judgment of field biologists in selecting representative riffles in each reach. DFWP provided no data to show that the riffles selected for study are representative of other riffles in the study reach or that the stream flow deemed necessary to preserve riffle habitat is reasonable for riffles elsewhere in the stream.

Several streams listed in Table 2 were evaluated by DFWP in their entirety and not broken into subreaches. The study riffles on these streams are located near their mouths. Although the instream flow requests are based on conditions near the mouth, the reservations are requested for the full length of the streams.

Stream flow generally increases with distance downstream. Usually as stream flow increases, so does channel width and depth. Thus, the channel width and depth are expected to be smaller near the headwaters of a stream than near the mouth. Because of this general relationship, less water is necessary to cover riffles near the head of a stream.

When asked to explain how it selected the reaches of stream for study, DFWP responded as follows (Spence 1988):

FIGURE A-2

An example of a relationship between wetted perimeter and flow for a stream riffle cross-section showing upper and lower inflection points and their relationship to fish food production.

Source: DFWP 1986

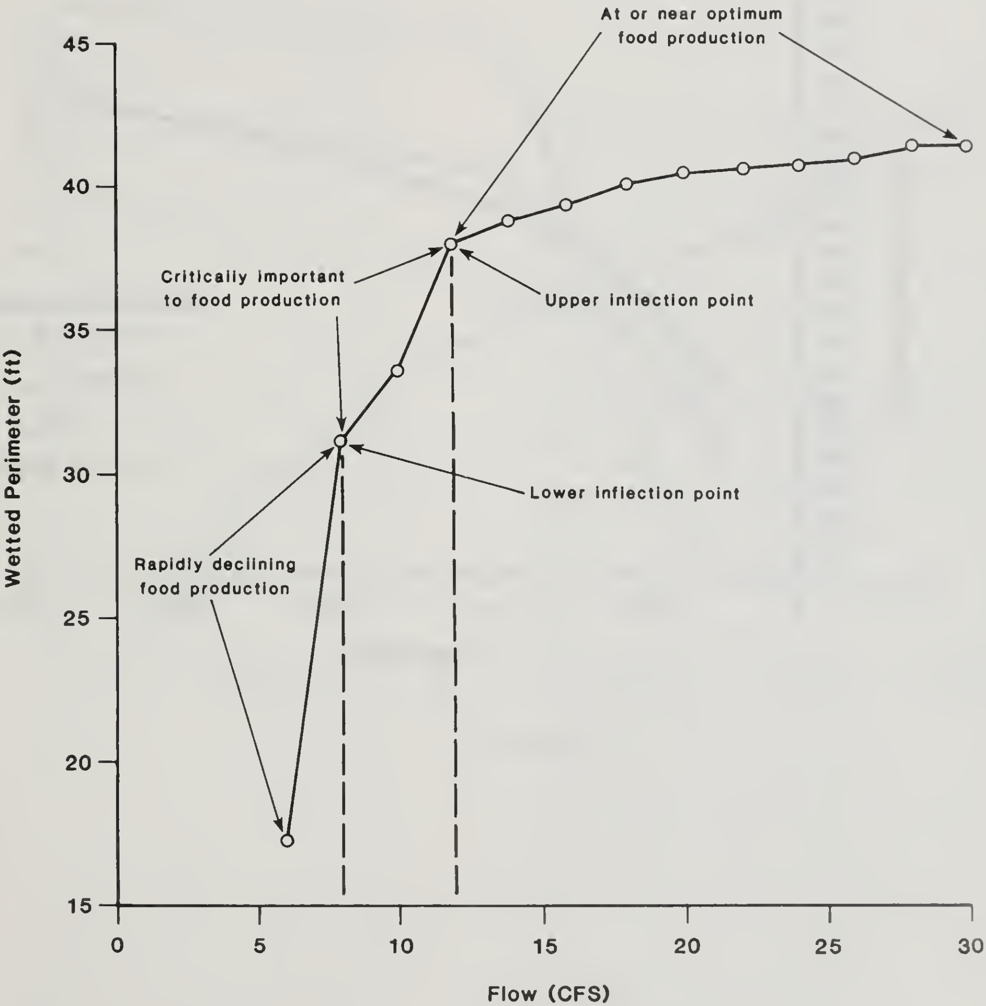


FIGURE A-3

Wetted perimeter flow curves for 3 riffle cross-sections, Clark Fork Reach 2.

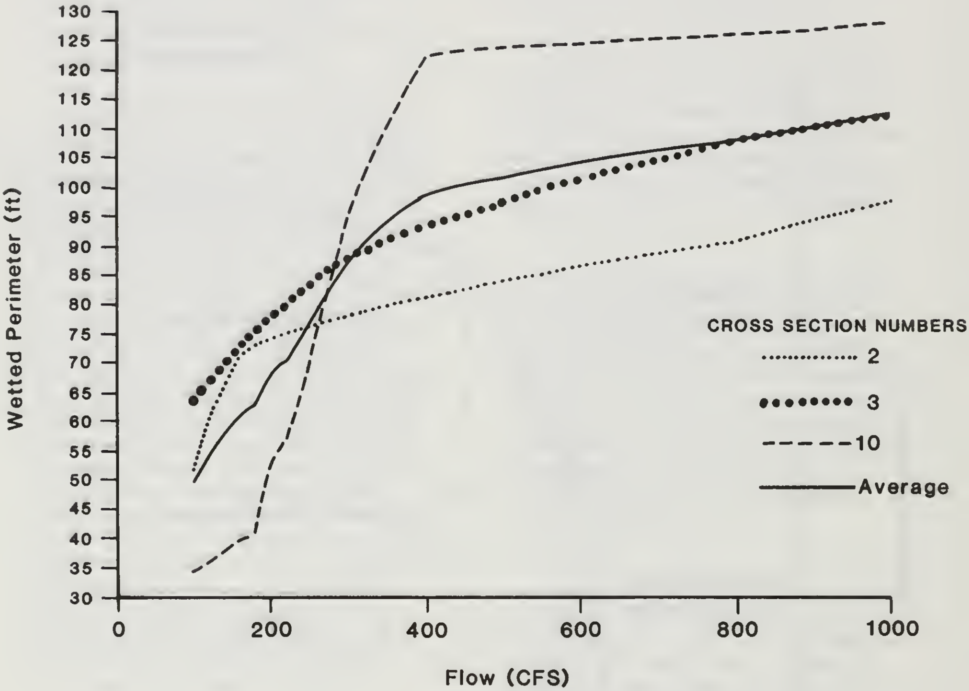
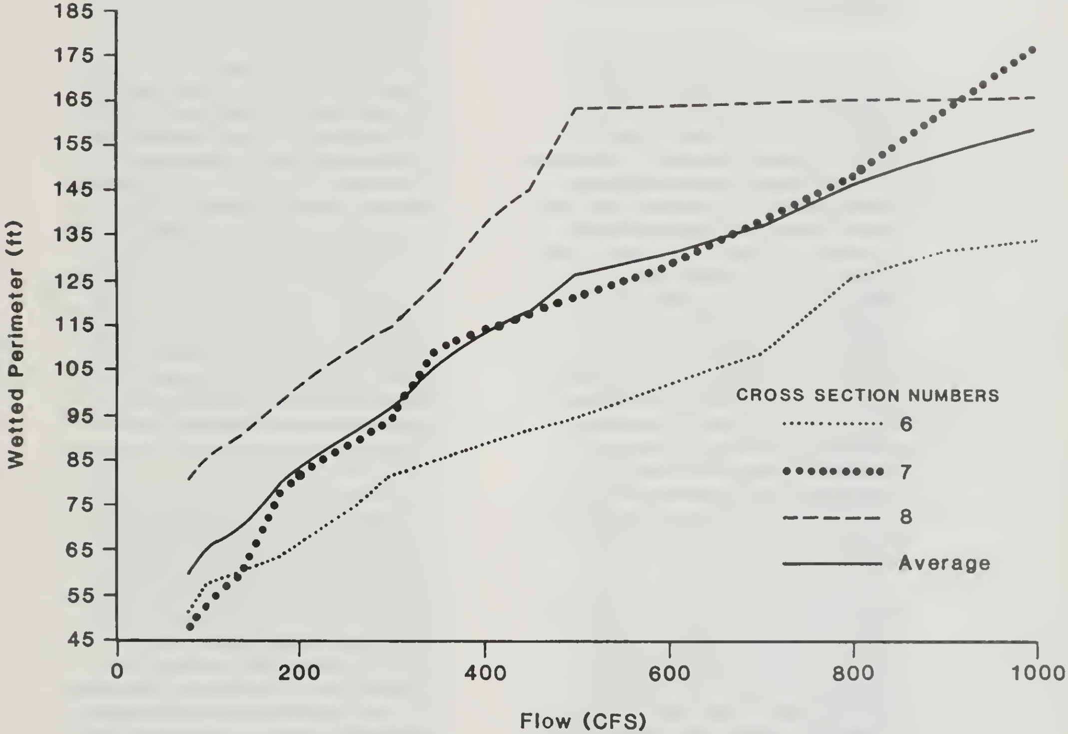


FIGURE A-4

Wetted perimeter flow curves for 3 riffle cross-sections, Clark Fork Reach 3.



"When deriving instream flow recommendations, two approaches can be used to establish reach boundaries on a particular waterway. The purpose of this section is to discuss the advantages and disadvantages of each approach and to describe the approach used by the MDFWP to establish reach boundaries for streams contained in the Clark Fork basin instream flow reservation application.

Approach #1 - Channel Structure and Flow Criteria

This approach is intended to identify those stream segments having a similar channel structure and flow regime. Boundaries are placed at all major tributaries, diversions and other locations where the flow regime significantly changes, and/or where channel structure changes, such as the point where the stream leaves a narrow, confined canyon and enters an open valley. Each stream is thus divided into a number of segments, or reaches which are, in themselves, essentially homogeneous. Once reach boundaries are delineated, a study site is established that represents the entire reach length. Thus, a flow recommendation derived at this strategically placed site would apply to the remainder of the reach as well, i.e., the same flow regime between the upper and lower reach boundaries would be established.

The major disadvantage of this approach is that each stream is comprised of many reaches. The practicality of collecting the required fish population information and cross-sectional data needed for instream flow determinations for each of these reaches becomes unwieldy where many different streams are involved. The time and cost of collecting, analyzing and summarizing these field data must be considered in the context of the department's personnel and financial resources.

Once instream flow reservations are granted, stream gauges have to be established to monitor compliance of junior water users with the terms of the instream reservation. The USGS estimates the annual cost of maintaining a year-round recording gauge at \$3,500-\$6,000, depending on the frequency of data collection and the sophistication of the recording instruments. While less expensive systems are available, the cost is still considerable if multiple gaging sites have to be established to monitor flows in several reaches of each stream.

Approach #2 - Water Supply and Depletion Criteria

In this approach, a flow recommendation is derived at a study site located near the lower end of each stream. To satisfy the instream flow requirement of this downstream site, water has to be delivered from upstream sources. The stream reach is thus defined as the segment of stream that supplies the water needed to satisfy the instream flow requirement for the lower stream. Having a similar flow regime between the upper and lower boundaries of the designated reach is not a criterion with this approach, and unlike Approach #1, the selected site is not intended to be representative of the channel and flow characteristics of the entire stream reach.

In the case of mountain tributary streams, the keying of recommendations to a site on the lower stream is both logical and defensible because these lower segments usually support the most game fish due to their greater flow, lower gradient and larger channel. Although man's activities can alter natural fish distribution and abundance, the lower stream is potentially the most productive portion of the total stream and typically possesses the higher fishery and recreational values.

Approach #2 appears to be a more practical means of addressing dewatering problems, particularly in those streams already subject to extensive dewatering. The most severe dewatering normally occurs in the lower, valley portions of most mountain streams because much of the irrigable land is located there. Because flow in the upper stream is typically less depleted, water in excess of

the instream flow needs for this upper segment is available for new consumptive uses, while, in the already depleted lower section, little or no surplus water is likely to be available. Therefore, new consumptive users, if allowed to deplete the excess water in the upstream reach, would also deplete water needed for instream purposes in the downstream reach. However, the further reduction of an already depleted water supply in the lower stream would be averted if all junior users on the entire stream were subject to an instream flow reservation derived for the lower stream. On such depleted streams, the establishment of a single reach extending from the mouth to the headwaters would address this potential problem. The reach boundaries would merely serve to identify those junior users who would be subject to the downstream reservation which is monitored at a site at, or near, the mouth of the stream.

In addition to practicality, an obvious advantage of this approach is the lower cost of having to establish only one study site for the collection of fish and cross-sectional data and one stream gauge to monitor each stream of interest. A potential disadvantage is also evident. If all upstream junior users are keying to a flow level on the lower stream, the potential exists for a single, large, consumptive user in the headwaters to severely dewater an upper stream segment without materially impacting flow near the stream's mouth,, where the instream flow is monitored and compliance enforced. However, the chance of this occurring is remote because large consumptive uses, especially those associated with agriculture are more likely to occur on the lower rather than on the upper stream. These large diversions would also be subject to the reservation as junior users.

A non-consumptive use in which water is diverted and then returned to the source up to several miles downstream - a characteristic of small hydroelectric development - poses a far greater threat to the upstream fishery under this approach. Because the diverted water is returned, flow of the lower stream would not be impacted, yet lengthy upstream segments could suffer severe or total dewatering. However, in the case of these small hydro developments a practical solution to these potential dewatering problems is to rely on FERC hydro license conditions, rather than on the water reservation process, to recommend and protect an instream flow for a specific project.

MDFWP Approach

The MDFWP did not strictly adhere to a single approach when establishing reach boundaries in the Clark Fork basin reservation application. Approach #1 was generally applied to the Clark Fork River itself, while approach #2 was generally used in the tributary streams.

Approach #1 was generally used on streams where at least some long term gauge records were available for a number of sites along the river, and reaches could be readily identified based on known water availability. In contrast, flow data were generally lacking for most of the tributary streams, making reach identification under approach #1 difficult without first investing considerable time and effort conducting field studies to establish points where significant flow changes occur. In general, insufficient flow data were available to accurately divide most tributary streams into homogenous reaches.

The department deviated somewhat from the guidelines of Bovee (1982) for identifying river reaches under approach #1. Changes in channel structure, a major criterion of Bovee (1982), were not considered in most cases. Also, the placement of boundaries where the flow regime "significantly" changed was broadly interpreted. Bovee (1982) states that reach boundaries are warranted only if accretions of depletions change the average base flow more than 10%. Our reach boundaries tended to greatly exceed the recommended 10% minimum. For

example, at USGS gauges between Reaches 1 and 2, 2 and 3, and 3 and 4 of the 120 mile-long Upper Clark Fork River, average base flow increased about 48, 68 and 58%, respectively. Under Bovee's flow criterion, more than four reaches should have been established. However, existing flow data were insufficient for delineating more than four reaches.

Even if more gauge data were available, the practicality of establishing more than four reaches on the Upper Clark Fork River is debatable when considering the procedures for monitoring and enforcement of the reservation.

Variations of both approaches #1 and #2 were employed by the Board of Natural Resources and Conservation when instream flow reservations were granted in the Yellowstone River Basin in 1978. In the Board's Order, the instream reservation for a number of major rivers was granted at the river's mouth. These include the Powder River (flows 218 miles within Montana), Tongue River (210 miles in Montana), Bighorn River (84 miles within Montana), and Stillwater River (68 miles long). Reservations were applied for by DFWP on two or more reaches on each of these streams. However, these reaches were not considered in the Board's order. The granted reservation on each stream was a single amount which encompassed the entire river's length, and compliance was to be monitored at a single site at the mouth. Thus, all junior water users throughout the length of these rivers are subject to a flow reservation established for the lower river.

A similar example of the Board's action is on Rock Creek near Red Lodge. DFWP applied for different flows in three separate reaches of the stream from the Montana-Idaho (sic) line to the mouth. However, in the Board's order, a single reach (from the National Forest boundary to the mouth (46 miles) was granted an instream reservation with no designation as to where such flows would be monitored. Similar actions by the Board occurred on Lower Willow Creek, Red Lodge Creek and Bluewater Creek where applied for reaches were not recognized in the Order. This approach (#2) is basically the same as that taken by the MDFWP for the majority of tributary streams in the upper Clark Fork. Like Many of the waterways in the Yellowstone reservation, the designated stream reaches are lengthy, encompassing the entire stream in most cases.....
From a practical standpoint, the protection of water reservations is key to any instream flow program, and monitoring of those flows is the key to protection. It makes little difference whether a granted flow is for a short reach or a long reach of stream. A monitoring site must be established which can be used to trigger the enforcement procedures. Only junior water users are affected. Shutting off only junior users above a site will affect actual stream flow within a reach in proportion to where the users are located and the amount of their appropriation. Therefore, it makes no difference whether there is more than one reach or what length the reach is, the junior users are the only ones affected.

On larger streams, designating more than one reach makes more sense because of the greater drainage area above a site and the larger number of tributaries which could have junior users on them. A more precise monitoring and enforcement program can be utilized in this case, whereas on the smaller streams it makes little difference.

DFWP currently monitors and enforces its Yellowstone reservations and Murphy Rights through the use of established USGS gaging stations on the main river and some major tributaries. This procedure appears to be an effective means of enforcement since the procedure also covers junior users on all tributaries above the gauge sites. Therefore, all junior users above the gauge sites are affected whether they are on the main stem or the tributaries. Prior existing rights are not affected and only the status quo of stream flow conditions at the time the reservations are granted is maintained." (Spence 1988).

In providing a justification for using the WETP methodology, DFWP cited studies in other areas which give credence to the validity of its assumptions. No such studies have been completed in the Clark Fork drainage. Metal toxicity problems in the Clark Fork drainage override concerns about flow and food production in some cases. Implicit in DFWP's rationale for flow recommendations is the hope that metal problems will eventually be cleaned up and no longer be a limiting factor. At this time, it cannot be guaranteed that toxicity problems will be reduced enough to avoid impacts to invertebrates and fish. However, cleanup activities have resulted in significant increases in invertebrates over roughly the last 15-20 years. Cleanup efforts are continuing and are just beginning to address the metal contamination along the Clark Fork floodplain.

Another concern raised in reviewing the accuracy of the WETP method used by DFWP is that on four tributary streams--Little Blackfoot River Reach 1, Snowshoe Creek, Dog Creek, and Boulder Creek--the stage-discharge relationship used to plot wetted perimeter flow relationship was developed using only two flow measurements at each stream cross section instead of three or more as used in the rest of the application (see Table A-2). Using two points instead of three may result in larger errors because the relationship between water height (stage) and flow (discharge) might not be correct.

Several steps are involved in graphing the relationship between flow and wetted perimeter. First, field data are gathered including:

1) cross sections along the bottom of a stream in a representative riffle;

2) a measurement of the stage (height of the water surface at a given flow) for each of the cross sections on three different dates and stages;

The stage-flow relationship is graphed on log-log graph paper or derived mathematically. Then graphs of wetted perimeter versus flow are prepared, relying on the stage discharge relationship plotted on log-log graph paper or on the mathematically derived relationship. The wetted perimeter versus flow curves for several riffles are averaged and these results are used to determine the high and low inflection points.

Error is more likely in the process if only two points are used to plot the stage-flow relationship. These two points should be widely separated. If three or more points are used, there is less chance for errors in defining the stage-flow relationship. Points that cluster close to each other are not as desirable as widely separated points. Bovee and Milhous (1978) demonstrated that the errors associated with using two data points instead of three resulted in larger errors in predicting the actual stage-flow relationship. Their results are presented in Table A-1.

Excellent discharge (flow) measurements in cross sections with relatively uniform nonturbulent flow may be off by ± 5 percent (Shields 1988). Thus, the stage discharge relationship may be off somewhat. When inaccuracies of ±5 percent were introduced in flow measurements made by DFWP on Reaches 2 and 3 of the Clark Fork, these artifically created errors did not make large differences when selecting inflection points. Despite the introduced errors, the flow at which the upper inflection point occurred fell within a 40-cfs range on Reach 3 and were nearly identical for the lower inflection point. For Clark Fork Reach 2, the flow where the upper inflection point occurred changed less than 30 cfs (see Figures A-5 and A-6).

The wetted perimeter methodology assumes that channel geometry remains unchanged during the course of field measurements. If significant changes in channel geometry were to occur, the stage-discharge relationship could be in error. Channel geometry may also change over a period of years, possibly changing the flows at which the inflection points occur.

Lastly, the predicted stage-discharge relationship may break down and not be accurate at very low flows, making wetted

perimeter and inflection point predictions somewhat tenuous. Nearly all the flows requested by DFWP fall within the range of measured flows (see Table A-2); thus the selection of inflection points for most requested flows are reasonably accurate.

Trihey (1988) noted that instream flow reservations based on the upper inflection point are likely to provide adequate flows to protect aquatic habitat.

Summary and Conclusions

1. Selection of inflection points can be subjective, especially if the slope of the wetted perimeter versus flow curve does not change dramatically with changes in flow.

2. Selection of a study reach near the mouth of a stream may result in an overestimate of the instream flow requirements near the headwaters of a stream.

3. For streams where only two points were used to derive the stage-discharge relationship, there is a larger potential for error when plotting wetted perimeter against flow.

4. Inaccuracies in flow measurements when only two flow measurements were made could result in different inflection points being selected.

5. Most requested flows fall within or very close to the range of flows measured in the field. Consequently, few errors due to extrapolation are expected.

6. For the most part, the DFWP methodology provides a reasonably accurate estimate of wetted perimeter. Inflection points fall within a relatively narrow range, even when inaccuracies of 5 percent in discharge measurements are considered. Thus, the inflection points can serve as indicators of abrupt changes in the amount of stream bottom that remains wet as flows change. Instream flows based on the upper inflection point are likely to provide adequate flows to protect aquatic habitat (Trihey 1988).

Table A-1. Mean percent error associated with the number of points used in establishing a stage-discharge relationship, using refined data with limits placed on the data used and range of extrapolation. Use of one point indicates application of Manning's equation.

	Number of points Used in Calibration					
Location of Gaging Stations	1	2	3	4	5	6
Oak Creek near Corvallis, OR	14.8	10.2	9.5	9.2	8.9	8.7
Yakima River at Umtanum, WA	18.2	2.7	2.5	2.3	2.2	2.2
American River near Nile, WA	17.6	6.1	5.8	5.8	5.4	5.3
Yampa River at Maybelle, CO	12.6	5.8	5.3	5.1	5.1	5.2
Yampa River at Steamboat Springs, CO	14.1	5.4	5.5	5.3	5.1	4.9
Cache la Poudre River at mouth, CO	24.4	5.2	4.9	4.7	--	--
South Platte River near Kersey, CO	26.2	5.3	4.9	4.7	--	--
North Branch, Elkhart River near Cusperville, IN	16.4	22.9	16.8	15.0	14.1	13.5
Elkhart River at Goshen, IN	20.6	7.1	6.6	6.2	6.0	5.9
St. Joseph River at Elkhart, IN	20.1	8.0	7.2	7.0	7.0	6.1

Table A-2. Characteristics of measurements made in deriving instream flow recommendations.

Stream	Single study reach located near mouth	At least 3 flows used to derive stage-discharge relationship	Flows used to derive stage-discharge relationship bracket requested instream flow
Warm Springs Creek			
Reach 1	No	Yes	Yes
Reach 2	No	Yes	Yes
Cable Creek	WETP method not used---------------------------		
Barker Creek	Yes	Yes	No[a]
Storm Lake Creek	No	Yes	No[b]
Twin Lakes Creek	Yes	Yes	Yes
Lost Creek	Yes	Yes	Yes
Racetrack Creek			
Reach 1	No	Yes	No[c]
Reach 2	No	Yes	Yes
Dempsey Creek	Yes	Yes	No[d]
Little Blackfoot River			
Reach 1	No	Yes[e]	Yes
Reach 2	No	Yes	No[f]
Snowshoe Creek	Yes	No[g]	No[g]
Dog Creek	Yes	No[h]	Yes
Gold Creek	Yes	Yes	Yes
Flint Creek			
Reach 1	No	Yes	No[i]
Reach 2	No	Yes	No[j]
Boulder Creek	Yes	No[k]	Yes
North Fork Flint Creek	Yes	Yes[l]	Yes
Stuart Mill Creek	WETP method not used-----------------------		
Harvey Creek	Yes	Yes[m]	No[m]
Clark Fork			
Reach 1	No	No[n]	Yes
Reach 2	No	No[o]	Yes
Reach 3	No	No[p]	Yes
Reach 4	No	No[q]	Yes

a. Measured flows were 13.5, 17.8, and 29.9 cfs compared to a requested flow of 12 cfs.
b. Measured flows were 12.6, 16.1, and 26.3 cfs compared to a requested flow of 10 cfs.
c. Measured flows were 36.5, 95.2, and 271.2 cfs compared to a requested flow of 26 cfs.
d. Measured flows were 6, 11, and 12.1 cfs compared to a requested flow of 3.5 cfs.
e. The WETP program was calibrated to flows of 16.1, 17.1, and 90.6 cfs. Because the lower two flows are very similar, a slight chance exists that "two-point error" may occur, but this is tempered by the flows being widely separated.
f. Measured flows were 111.6, 402, 435, and 845 cfs compared to a requested flow of 110 cfs. This very small extrapolation based on a wide variety of measured flows is reasonable.
g. Measured flows were 10.8 and 18.2 cfs compared to a requested flow of 9 cfs. "Two-point error" is possible and results were extrapolated beyond the range of measured flows.
h. The WETP program was calibrated to flows of 11.5 and 114.3 cfs. Although these flows are widely separated, a potential for "two-point error" exists.
i Measured flows were 72.2, 106, and 127 cfs compared to a requested flow of 50 cfs.
j. Measured flows were 214.9, 224.4, and 381.3 cfs compared to a requested flow of 45 cfs. Errors due to extrapolation may occur.
k. The WETP program was calibrated to flows of 10.7 and 79 cfs. A chance for "two-point error" exists, but is tempered by the fact that the measured flows are widely separated.
l. The WETP program was calibrated at flows of 4.0, 5.3, and 80.2 cfs. Because the lower two flows are very similar, there is a slight chance that a "two-point error" might still occur, but this is tempered by the fact that the measured flows are widely spaced.
m. The WETP program was calibrated using flows of 3.6, 3.7, and 40.3 cfs. Because the lower two flows are very similar, a slight potential exists for a "two-point error." The upper inflection point of 5 cfs is within the range of measured flows, but the requested flow cf 3 cfs and the lower inflection point lie outside the measured flows.
n. Slight potential for "two-point error" exists because the WETP was calibrated to flows measured at 69.7 and 318.3 cfs.
o. Slight potential for "two-point error" exists because the WETP program was calibrated to flows of 118 and 445 cfs.
p. Slight potential for "two-point error" exists because the WETP program was calibrated to flows of 237.4 and 628.2 cfs.
q. Slight potential for "two-point error" exists because the WETP program was calibrated to flows 499 and 1,597 cfs.

FIGURE A-5

Changes in wetted perimeter versus flow curves when errors of ± 5% are artificially introduced into DFWP's stage-discharge data.

CLARK FORK REACH 2

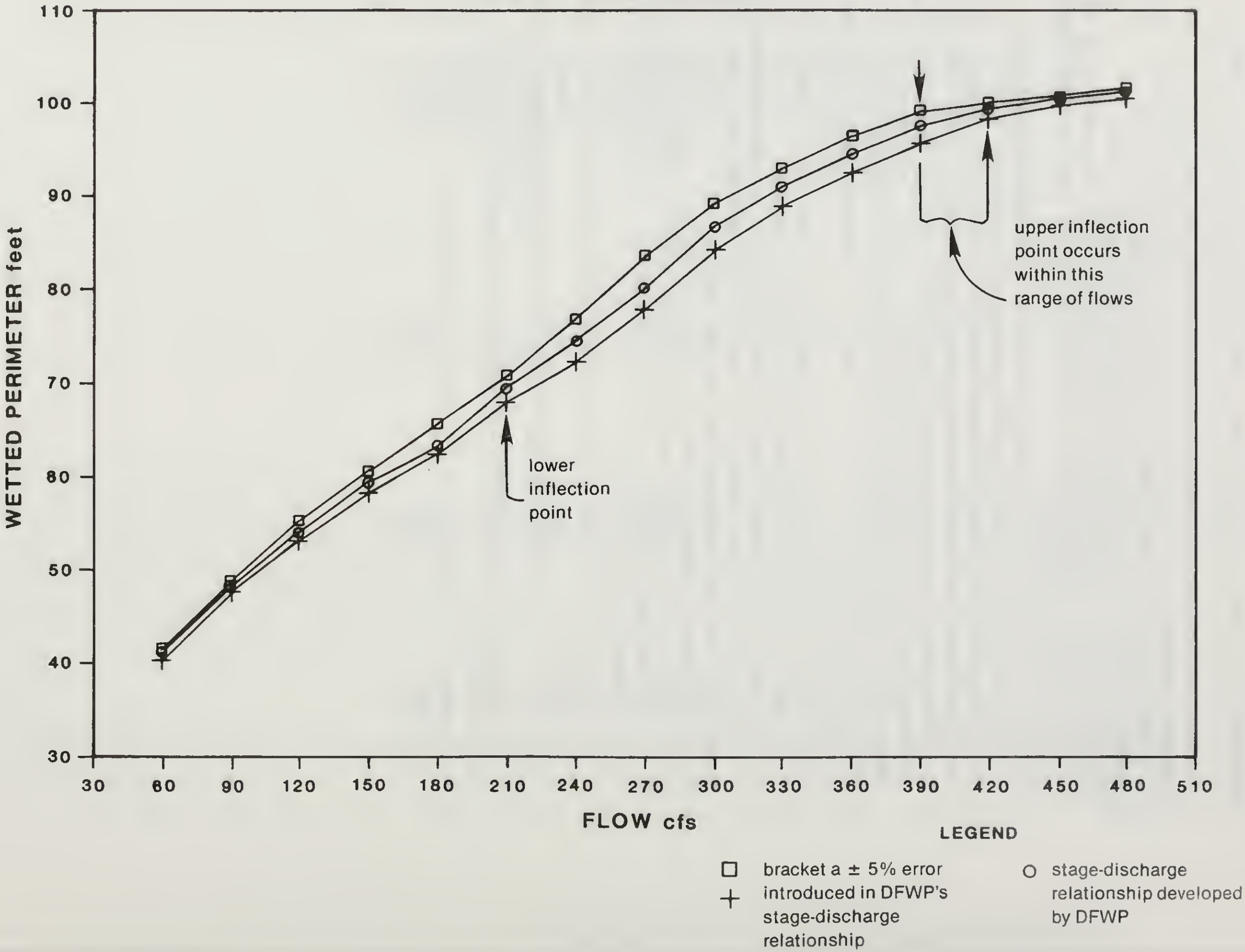
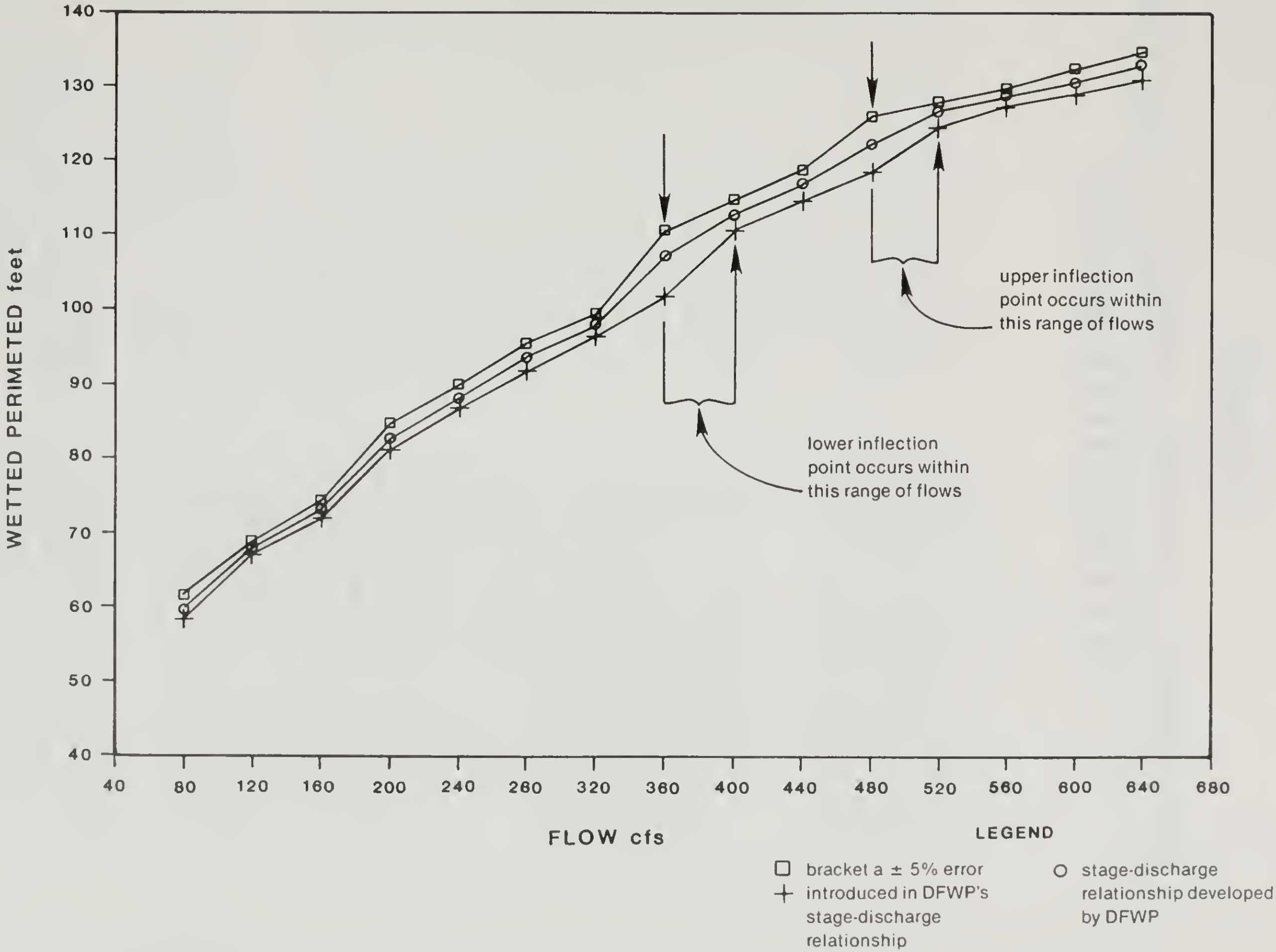


FIGURE A–6

Changes in wetted perimeter versus flow curves when errors of ± 5% are artificially introduced into DFWP's stage-discharge data.

CLARK FORK REACH 3



APPENDIX B

METHODS USED TO ESTIMATE PHYSICAL WATER AVAILABILITY

To assess water availability in the upper Clark Fork basin, DNRC hydrologists developed three computer simulation models. The first model simulates flows in the North Fork of Lower Willow Creek drainage and was used to assess the water supply and reliability of the proposed GCD project in this basin. The second model simulates flows in the Flint Creek basin and was used to determine the effect of the proposed GCD North Fork of Lower Willow Creek project on the flows of Flint Creek between the mouth of Lower Willow Creek and the mouth of Flint Creek. Figure B-1 presents a schematic of the Flint Creek basin as simulated in this model. The final model simulated the main-stem flows of the Clark Fork from its headwaters to the Noxon Rapids below Noxon Dam, as well as the flows of major tributaries at their mouths. The purpose of this model was to assess the impact of GCD's proposed project on the North Fork of Lower Willow Creek and the development of irrigation on an additional 8,362 acres (as identified in Elliott 1986 and DNRC--Appendix D-6) on flows of the Clark Fork. Figure B-2 presents a schematic of the Clark Fork basin as simulated in this model.

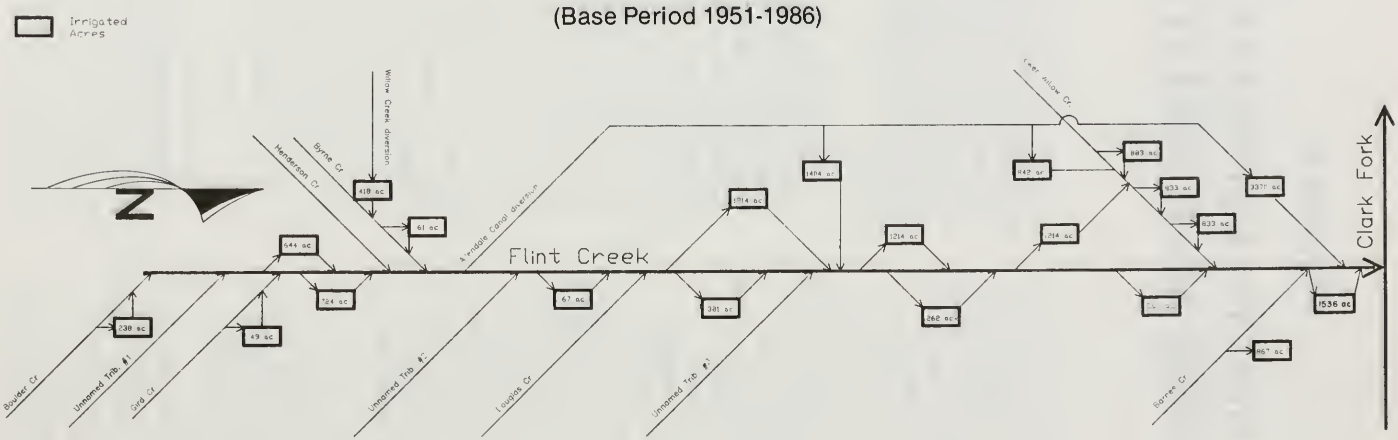
All of the models employ mass balance computations to simulate streamflows, reservoir operations, diversions, and return flows at various nodes within the Clark Fork basin. The models operate on a monthly time step over the base period 1951-1986.

Data input to the models include gauged and estimated streamflows, crop irrigation requirements, irrigation efficiencies, irrigated acres, reservoir capacities, area-capacity relationships, and evaporation rates. Streamflow data were obtained from U.S. Geological Survey (USGS) gauging records or estimated using techniques described in DFWP's application (Montana DFWP 1986b). Estimates of crop irrigation requirements were obtained from the Soil Conservation Service (USDA 1967). Estimates of irrigation efficiencies were based on information used by Elliot (1986), GCD (1987), and USDA (1978).

Return flows were estimated by subtracting crop consumptive use and an estimate of non-beneficial consumptive use from the irrigation diversion. Non-beneficial consumptive use was estimated by assuming that approximately 15 percent of the water diverted in excess of the crop consumptive use was lost to evaporation, phreatophyte use, or deep percolation to non-contributing groundwater sources. The remaining 85 percent of excess diverted water was assumed to be returned to the streams. Return flows reenter receiving streams over a period of several months (Glover 1978; Brustkern 1986), with most of the return reaching the receiving stream in the first two to three months after irrigation. DNRC analyses assumed that approximately 50 percent of the excess diverted water returns to the receiving stream in the month of irrigation and 25 percent returns in the month following irrigation. Return flows in each subsequent month are assumed to be one-half as much as the previous month until returns are effectively zero.

The Flint Creek basin model was checked by comparing modeled flows for existing conditions to limited historic flow data collected near the mouth of Flint Creek. Comparisons generally indicated good agreement between the two sets of data. Thus, key assumptions used developing the model are likely to be reasonable.

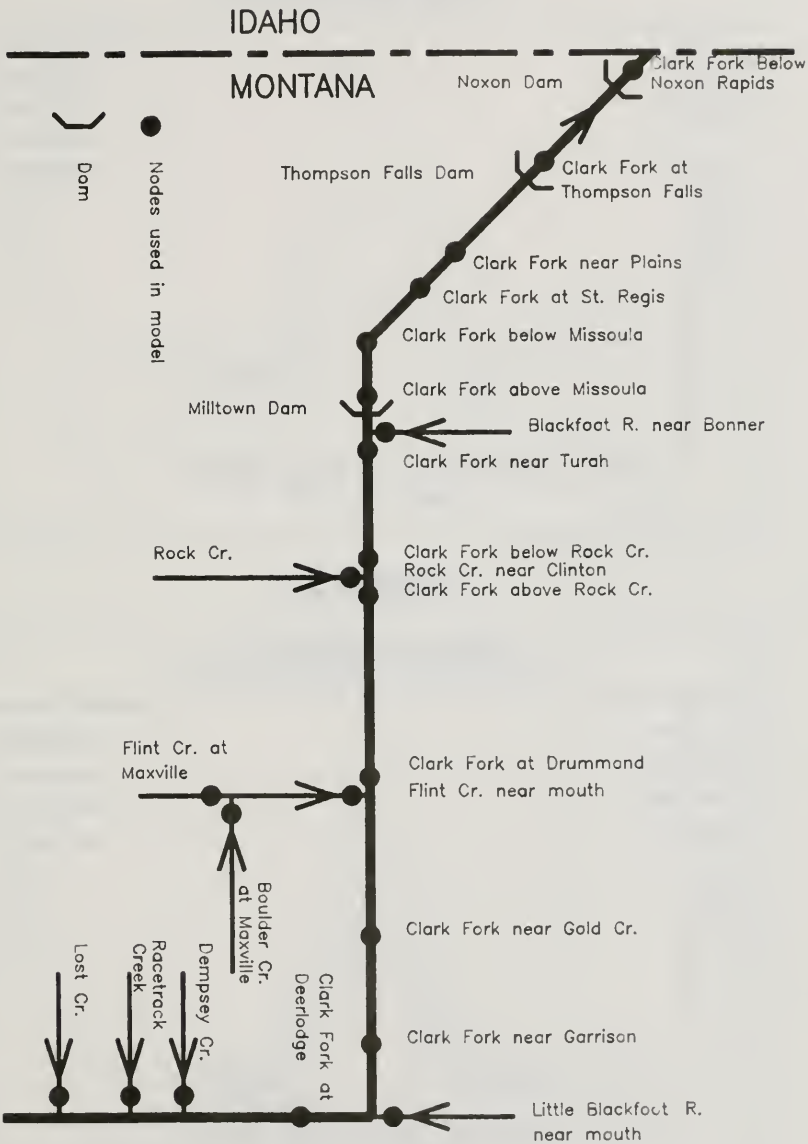
Figure B-1. Flint Creek Water Availability Demand Model
(Base Period 1951-1986)



Source: Sando 1988.

Figure B-2. Clark Fork Basin Model

(Base Period 1951-1986)



Source: Holnbeck 1988.

FIGURE B-3

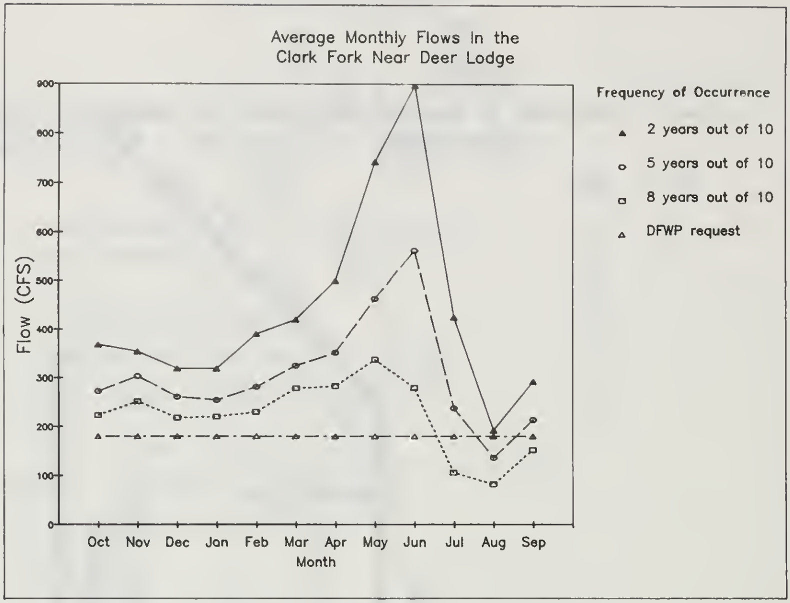


FIGURE B-4

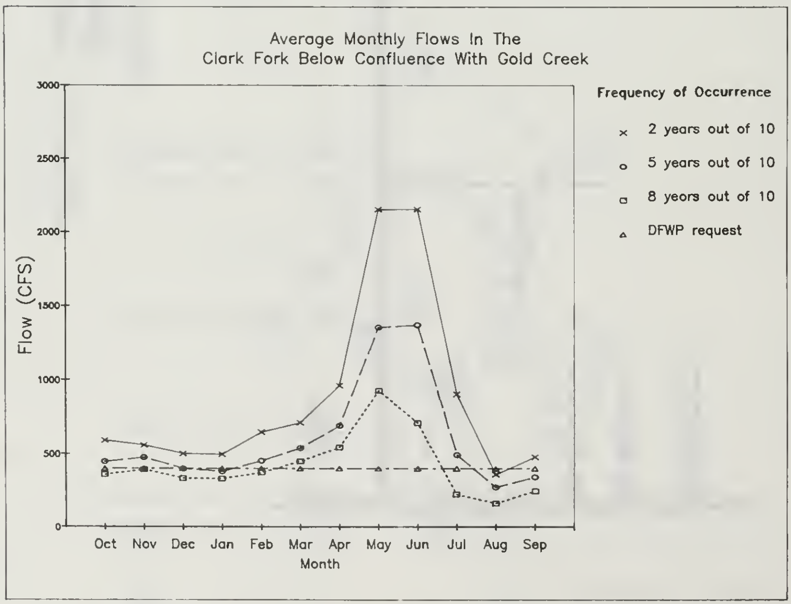


FIGURE B-5

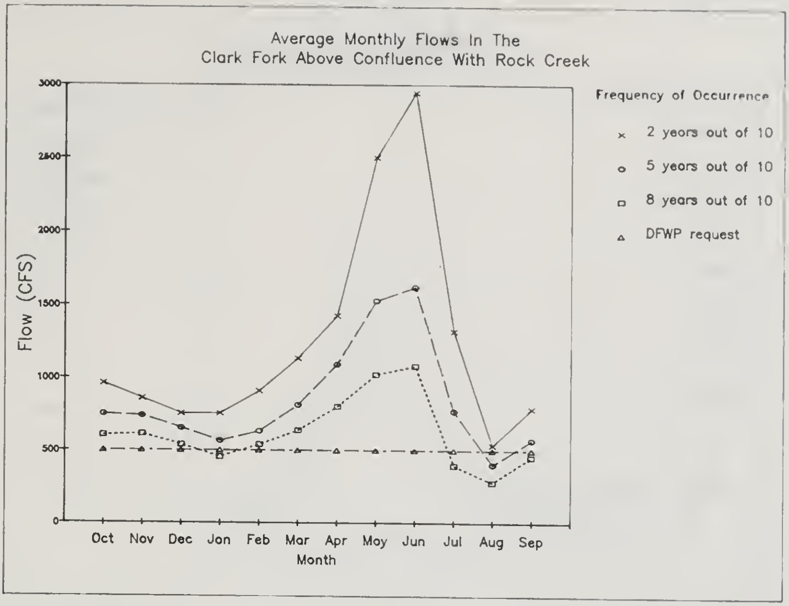


FIGURE B-6

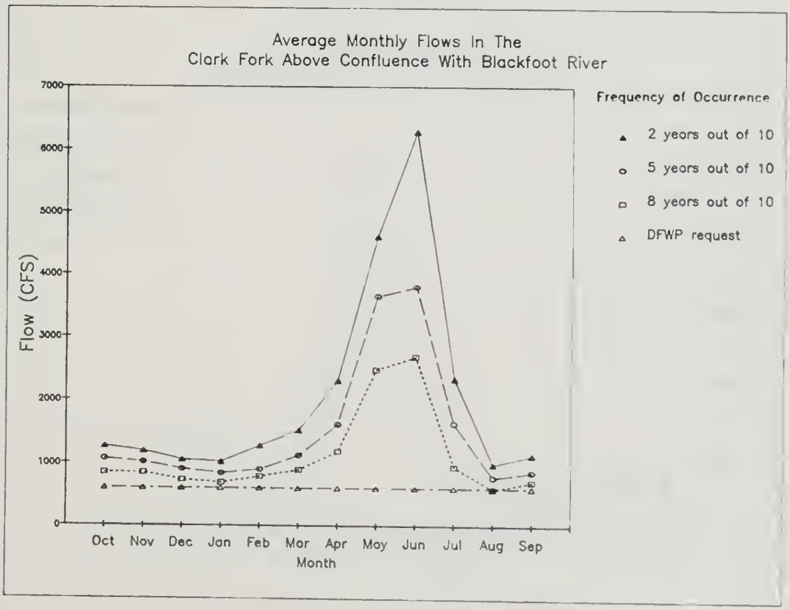


FIGURE B-7

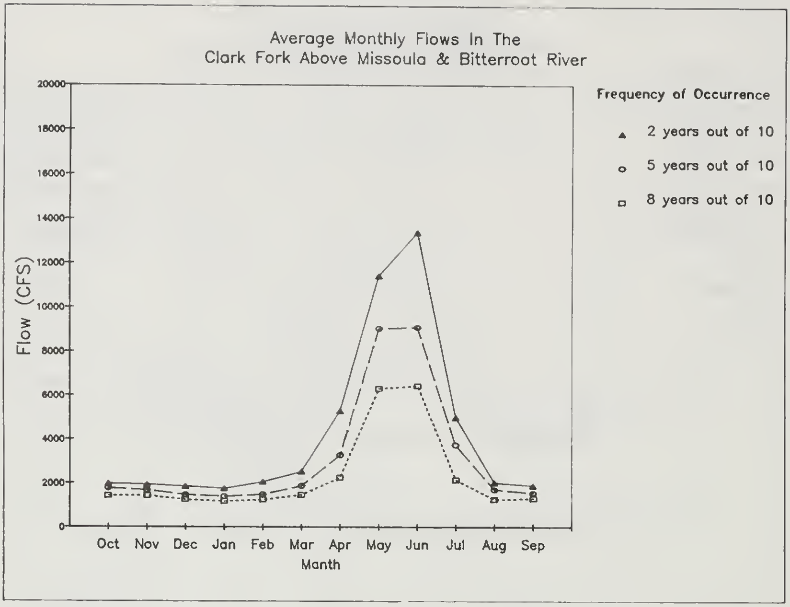


FIGURE B-8

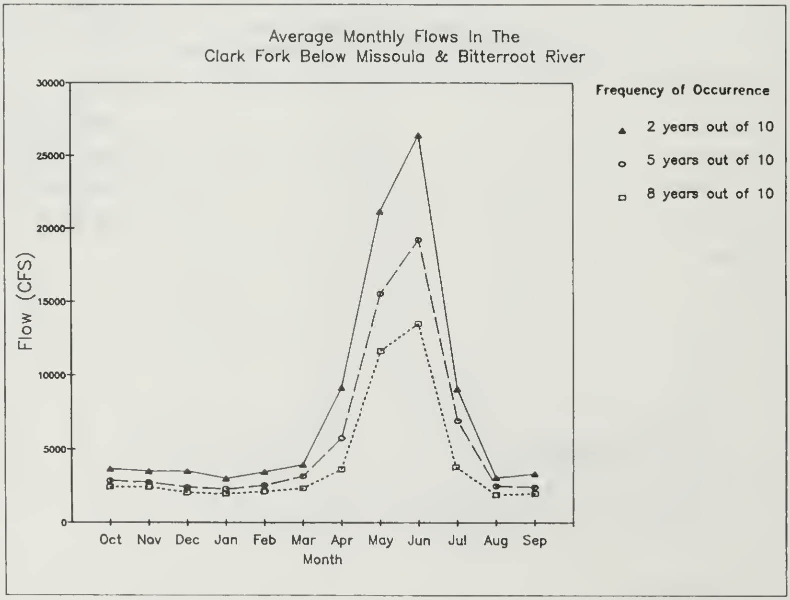


FIGURE B-9

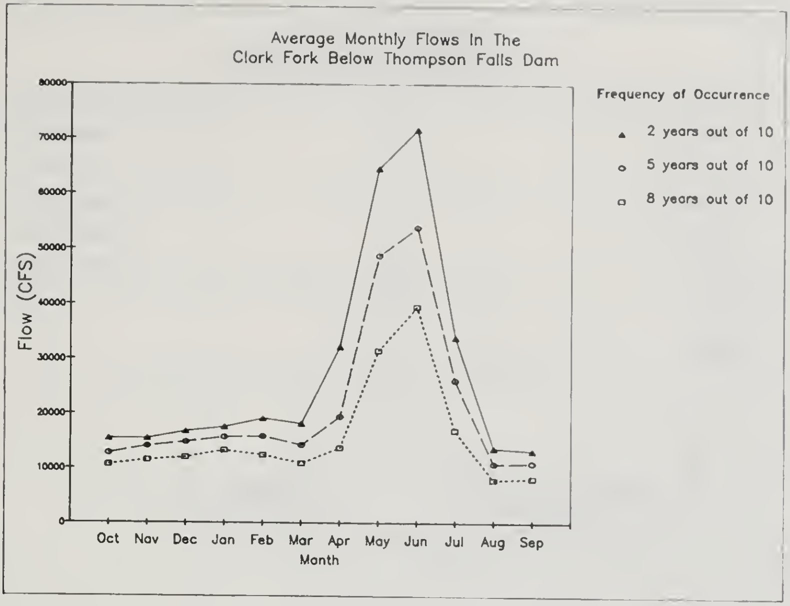


FIGURE B-10

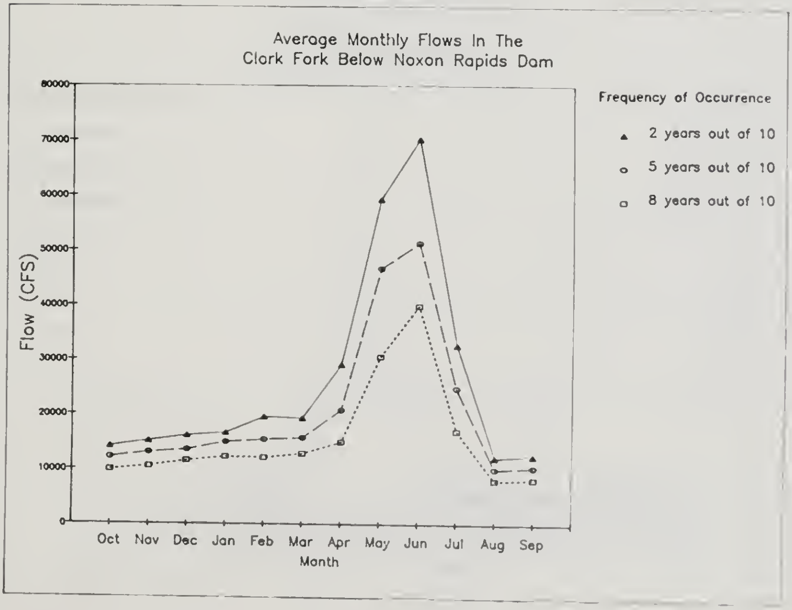


FIGURE B-11

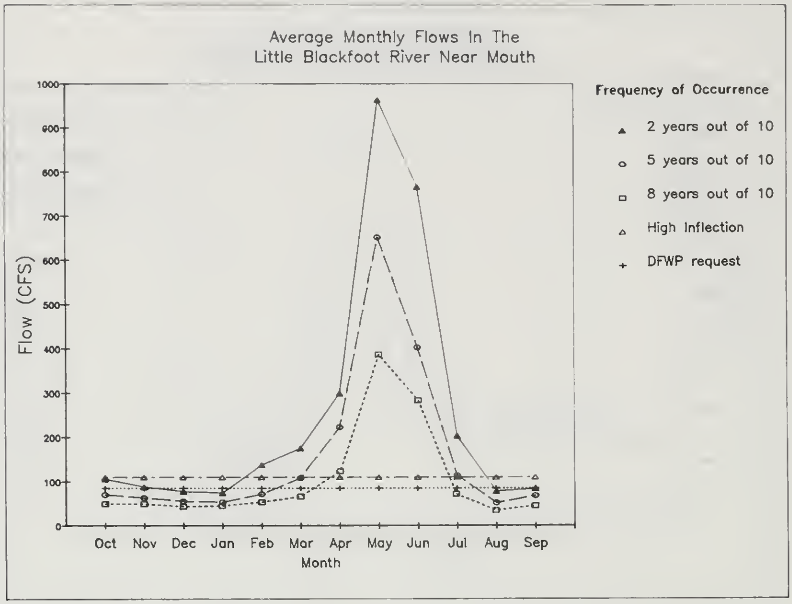


FIGURE B-12

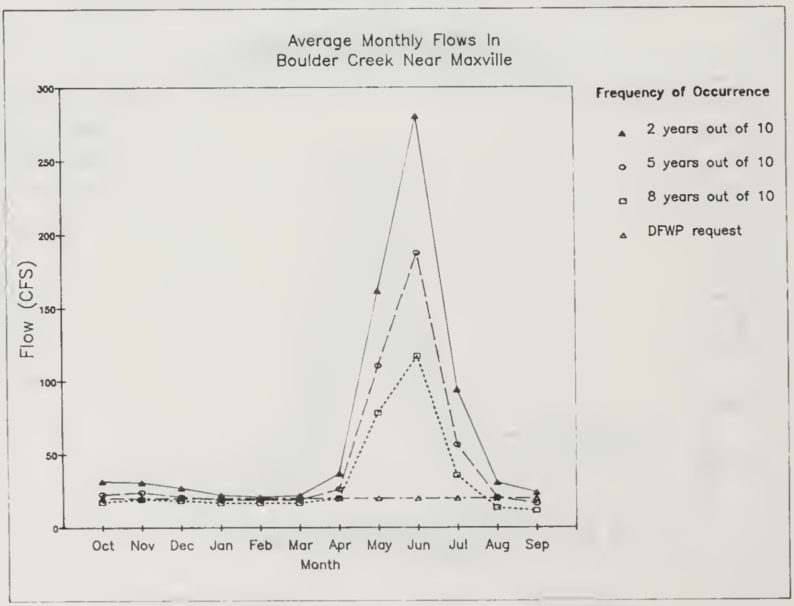


FIGURE B-13

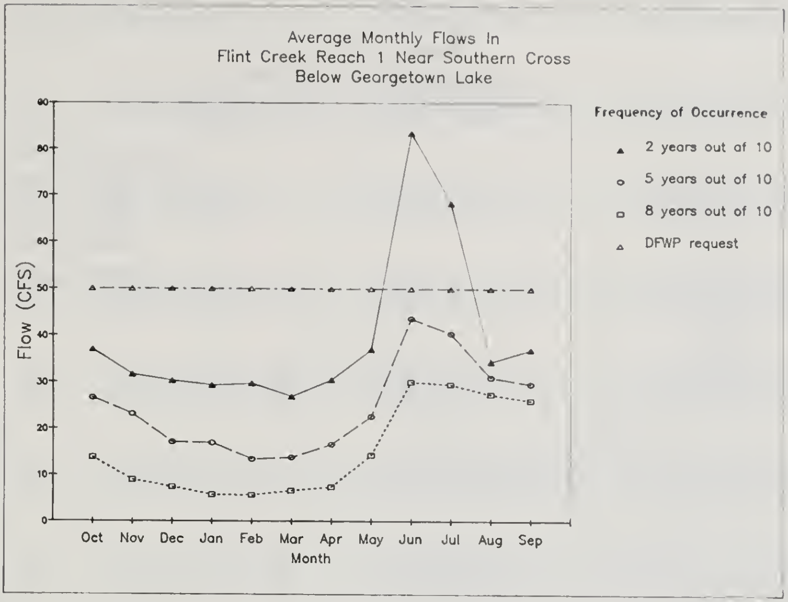


FIGURE B-14

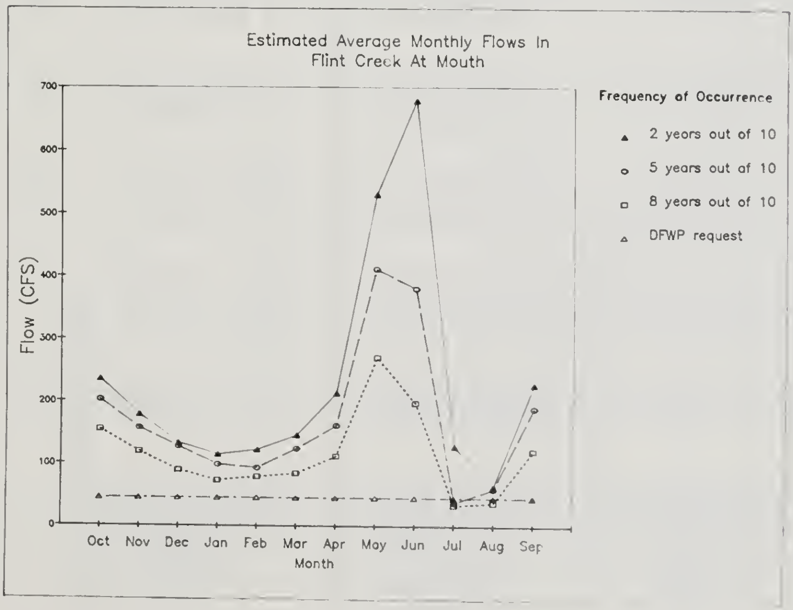


FIGURE B-15

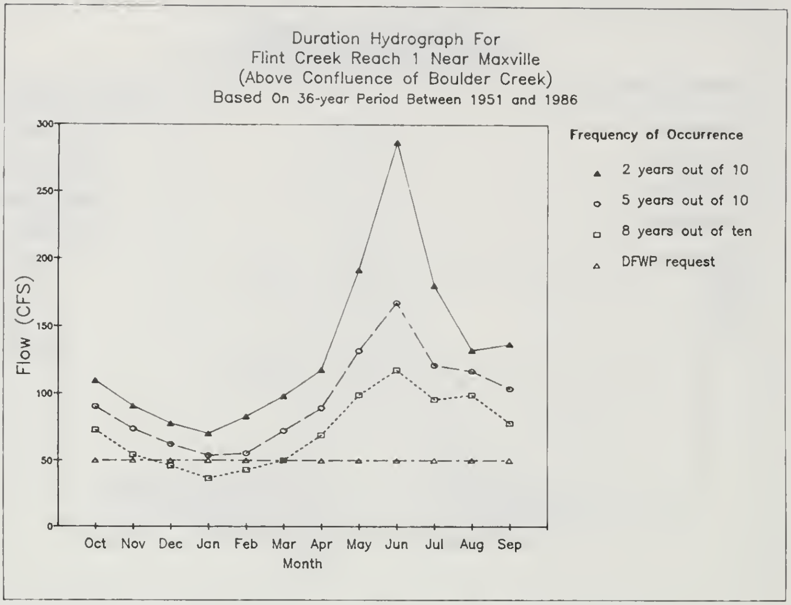

Duration Hydrograph For
Flint Creek Reach 1 Near Maxville
(Above Confluence of Boulder Creek)
Based On 36-year Period Between 1951 and 1986
Flow (CFS)
300
250
200
150
100
50
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
Frequency of Occurrence
2 years out of 10
5 years out of 10
8 years out of ten
DFWP request

TABLE 8-1. CLARK FORK WATER AVAILABILITY—DEMAND MODEL

Existing Conditions without Reservations

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork near Deer Lodge (cfs)												
Average	300.8	308.8	277.7	271.4	303.0	342.3	387.6	519.7	620.5	287.6	148.0	229.1
90 Percentile	209.1	239.6	205.1	206.8	206.4	260.9	244.7	246.9	193.0	78.2	56.9	127.9
80 Percentile	223.1	251.4	217.7	220.9	229.4	278.0	282.3	337.6	279.3	106.2	81.5	152.1
60 Percentile	267.4	275.2	250.6	233.8	260.6	301.4	331.2	444.2	496.9	202.2	123.9	196.1
50 Percentile	272.4	303.4	261.0	254.2	281.3	324.7	351.9	462.3	561.7	237.1	136.2	213.6
20 Percentile	368.2	354.1	319.0	318.8	390.3	419.7	499.1	742.9	897.4	423.9	191.9	292.2
Minimum	165.1	209.0	198.0	199.5	190.9	247.0	208.7	99.0	95.2	29.9	34.4	110.0
Maximum	547.0	500.9	573.1	490.0	613.6	586.0	780.2	1038.3	1553.5	947.3	509.6	433.9
Clark Fork above Confluence with Little Blackfoot River (cfs)												
Average	300.8	308.8	277.7	271.4	303.0	342.3	387.6	519.7	620.5	287.6	148.0	229.1
90 Percentile	209.1	239.6	205.1	206.8	206.4	260.9	244.7	246.9	193.0	78.2	56.9	127.9
80 Percentile	223.1	251.4	217.7	220.9	229.4	278.0	282.3	337.6	279.3	106.2	81.5	152.1
60 Percentile	267.4	275.2	250.6	233.8	260.6	301.4	331.2	444.2	496.9	202.2	123.9	196.1
50 Percentile	272.4	303.4	261.0	254.2	281.3	324.7	351.9	462.3	561.7	237.1	136.2	213.6
20 Percentile	368.2	354.1	319.0	318.8	390.3	419.7	499.1	742.9	897.4	423.9	191.9	292.2
Maximum	165.1	209.0	198.0	199.5	190.9	247.0	208.7	99.0	95.2	29.9	34.4	110.0
Minimum	547.0	500.9	573.1	490.0	613.6	586.0	780.2	1038.3	1553.5	947.3	509.6	433.9
Little Blackfoot River near Mouth (cfs)												
Average	73.8	68.4	66.0	61.5	90.8	119.6	225.3	674.1	523.8	132.1	57.3	65.9
90 Percentile	39.7	44.1	43.0	42.4	45.9	57.1	105.8	228.7	178.9	26.0	20.5	36.4
80 Percentile	49.8	49.4	43.4	45.0	54.4	66.0	123.0	384.8	283.8	70.8	34.3	45.0
60 Percentile	59.8	56.0	50.6	50.0	65.6	89.6	185.4	602.2	390.6	107.2	41.6	63.6
50 Percentile	70.5	63.0	55.5	53.5	72.0	108.0	222.5	650.0	402.5	113.0	52.0	68.5
20 Percentile	105.6	87.8	77.5	74.4	137.8	175.0	298.8	963.2	765.4	202.8	78.2	84.0
Minimum	35.0	40.0	38.0	37.0	33.0	45.0	89.0	94.0	65.0	24.0	9.0	20.0
Maximum	129.0	122.0	199.0	135.0	233.0	271.0	486.0	1460.0	1803.0	410.0	191.0	115.0

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork below Confluence with Little Blackfoot River (cfs)												
Average	374.6	377.2	343.8	332.8	393.8	461.8	612.9	1193.8	1144.3	419.7	205.3	295.0
90 Percentile	253.2	290.6	250.4	248.0	273.3	324.5	382.0	610.1	436.5	110.5	85.0	162.4
80 Percentile	272.7	303.7	268.8	265.0	283.3	342.1	436.9	757.7	601.7	178.2	112.7	209.7
60 Percentile	325.7	334.4	306.2	282.2	321.2	413.7	528.0	1107.4	914.9	318.6	178.0	255.3
50 Percentile	351.9	356.4	313.4	314.2	353.6	445.3	593.7	1187.2	1006.9	355.1	188.2	280.5
20 Percentile	471.3	442.6	385.1	393.6	502.0	603.8	768.4	1528.2	1657.5	596.5	262.1	371.5
Minimum	200.1	281.0	240.1	244.5	223.9	294.8	297.7	206.8	176.9	55.8	51.4	133.0
Maximum	636.0	622.9	772.1	625.0	789.6	842.0	1248.2	2431.0	3356.5	1357.3	700.6	548.9
Clark Fork below Confluence with Gold Creek (cfs)												
Average	489.7	484.5	432.5	414.9	498.6	572.6	754.7	1487.9	1498.0	601.7	291.1	369.6
90 Percentile	338.4	373.7	320.5	309.6	336.4	431.0	471.5	647.7	453.3	162.5	128.8	210.1
80 Percentile	358.3	393.6	334.8	329.7	373.9	449.8	543.6	928.9	707.8	224.1	160.5	246.3
60 Percentile	436.7	429.1	379.0	355.4	414.7	500.6	648.4	1305.9	1213.1	420.4	254.1	317.8
50 Percentile	446.7	474.8	399.5	380.0	442.7	540.0	690.1	1353.4	1371.2	493.0	272.4	342.0
20 Percentile	590.8	557.8	500.7	496.1	646.9	711.1	961.6	2154.5	2155.5	903.4	359.8	479.0
Minimum	268.8	351.0	293.0	303.2	311.2	408.1	402.1	287.1	232.4	85.8	67.2	178.2
Maximum	890.4	784.1	895.5	744.8	1000.5	968.2	1503.4	3011.1	3792.3	1969.5	994.4	702.4
Clark Fork below Confluence with Flint Creek (cfs)												
Average	703.2	674.9	579.1	557.2	667.6	756.7	963.1	1724.4	1822.5	768.2	369.9	547.5
90 Percentile	486.2	520.9	427.3	407.4	448.6	566.4	596.8	744.5	546.0	205.7	161.0	308.9
80 Percentile	518.8	546.6	449.0	433.6	485.0	585.8	688.6	1067.6	843.2	280.6	200.6	385.8
60 Percentile	623.8	598.2	511.6	467.6	553.0	653.2	820.8	1499.4	1461.6	532.2	302.2	467.0
50 Percentile	638.0	659.5	532.0	500.0	611.5	724.5	861.0	1590.0	1652.0	624.0	337.0	503.0
20 Percentile	844.0	779.0	676.8	652.2	862.6	917.2	1233.2	2476.4	2698.0	1150.6	516.2	719.0
Minimum	384.0	492.0	391.0	399.0	415.0	537.0	509.0	330.0	280.0	109.0	84.0	262.0
Maximum	1272.0	1089.0	1194.0	1190.0	1334.0	1274.0	1903.0	3461.0	4569.0	2493.0	1243.0	1033.0

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clerk Fork above Confluence with Rock Creek (cfs)												
Average	785.0	758.1	682.5	614.6	723.4	876.1	1183.3	1757.8	1925.7	908.7	426.2	640.0
90 Percentile	579.8	575.2	481.5	418.9	501.6	591.3	653.2	696.7	714.3	276.3	209.6	390.6
80 Percentile	603.4	611.3	538.4	456.0	539.1	636.8	801.6	1020.4	1081.4	391.3	280.3	455.8
60 Percentile	711.8	714.5	615.6	528.1	609.7	733.2	989.8	1391.2	1384.4	590.4	356.4	529.8
50 Percentile	749.0	738.2	652.8	565.1	632.0	813.8	1092.0	1531.3	1622.8	770.0	401.8	571.5
20 Percentile	960.6	857.6	753.3	754.5	909.2	1134.4	1426.6	2504.3	2945.7	1320.2	535.8	789.0
Minimum	438.0	544.0	376.3	283.0	423.1	467.4	512.4	422.1	371.1	162.0	154.7	345.0
Maximum	1362.0	1172.7	1366.1	1190.0	1322.0	1771.0	2443.1	3615.0	4701.0	2628.5	1293.1	1382.0
Clerk Fork below Confluence with Rock Creek (cfs)												
Average	1068.1	1000.9	894.8	809.5	933.3	1119.3	1708.1	3507.4	4088.0	1712.0	764.4	926.8
90 Percentile	788.5	791.3	644.0	570.6	657.3	775.7	984.4	2087.6	1700.9	721.2	451.6	633.3
80 Percentile	844.8	825.7	714.1	628.3	729.6	837.5	1136.3	2340.5	2608.9	915.7	555.1	710.0
60 Percentile	953.4	938.9	801.3	716.9	797.8	943.2	1358.8	2996.8	3364.2	1387.0	665.8	807.2
50 Percentile	1060.5	988.4	869.7	758.2	837.5	1040.5	1560.8	3463.7	3680.1	1605.5	734.4	857.5
20 Percentile	1259.0	1122.3	1020.5	961.7	1187.2	1412.3	2198.9	4337.7	6023.2	2282.1	925.1	1116.4
Minimum	633.0	708.0	569.2	490.0	584.9	623.4	756.4	976.0	949.1	429.0	316.7	555.0
Maximum	1836.0	1602.7	1826.1	1459.0	1580.0	2121.0	3351.1	7266.1	8456.1	4536.5	1928.1	1769.0
Clerk Fork above Confluence with Bleckfoot River (cfs)												
Average	1073.1	1028.1	926.2	882.1	1005.6	1198.7	1789.4	3685.2	4223.2	1751.0	805.3	928.6
90 Percentile	788.5	817.1	698.7	620.5	708.4	826.4	1035.7	2150.5	1755.5	737.3	475.3	633.3
80 Percentile	844.8	844.6	733.0	684.6	788.2	893.0	1182.6	2482.6	2684.8	932.4	586.4	701.6
60 Percentile	953.4	961.4	841.0	803.4	857.8	993.6	1416.0	3148.8	3473.4	1417.8	723.8	807.2
50 Percentile	1063.5	1011.5	902.5	837.0	900.0	1121.5	1612.0	3645.0	3796.5	1626.5	772.5	857.5
20 Percentile	1263.8	1186.8	1050.2	1021.2	1276.0	1516.2	2305.8	4605.6	6290.2	2336.0	979.8	1126.6
Minimum	633.0	734.0	586.0	525.0	628.0	664.0	795.0	1024.0	977.0	452.0	332.0	555.0
Maximum	1836.0	1639.0	1883.0	1477.0	1714.0	2275.0	3535.0	7665.0	8810.0	4646.0	2056.0	1769.0

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clerk Fork above Missoula and Bitterroot River (cfs)												
Average	1775.6	1701.9	1550.4	1465.8	1645.3	1997.7	3789.2	8918.2	9691.5	3722.9	1667.3	1637.8
90 Percentile	1317.5	1354.8	1175.0	1097.8	1186.6	1334.2	1978.4	5603.9	4800.6	1752.8	1079.2	1232.7
80 Percentile	1421.6	1427.8	1242.8	1171.8	1248.4	1465.2	2246.6	6303.4	6427.2	2162.8	1243.0	1314.0
60 Percentile	1580.6	1569.2	1386.8	1311.8	1427.2	1634.0	2944.6	8266.0	8685.2	3254.0	1565.0	1446.6
50 Percentile	1763.0	1667.5	1458.0	1389.0	1479.0	1866.5	3261.5	9027.0	9075.5	3721.0	1695.0	1540.5
20 Percentile	1971.4	1927.6	1842.0	1748.6	2055.2	2521.2	5280.8	11408.0	13388.0	4981.8	2010.0	1876.8
Minimum	1084.0	1218.0	1097.0	1015.0	1119.0	1133.0	1570.0	2607.0	2149.0	1101.0	774.0	965.0
Maximum	2987.0	2852.0	3323.0	2546.0	3255.0	4124.0	7438.0	17240.0	19270.0	8759.0	3448.0	2874.0
Clerk Fork below Missoula and Bitterroot River (cfs)												
Average	3079.4	2973.3	2700.4	2487.2	2773.1	3294.1	6334.0	18238.3	19485.2	6866.9	2569.9	2679.3
90 Percentile	2143.0	2302.9	2023.2	1898.6	1929.1	2214.1	3240.5	10344.1	9423.9	2621.6	1522.8	1870.1
80 Percentile	2448.0	2436.2	2067.0	1967.6	2164.5	2357.7	3673.1	11618.6	13523.8	3813.1	1915.1	2006.7
60 Percentile	2757.9	2635.5	2290.1	2177.7	2475.4	2890.1	5008.2	14586.6	16749.3	5917.1	2254.0	2280.4
50 Percentile	2870.1	2760.8	2436.1	2291.4	2572.7	3195.6	5783.0	15539.5	19236.6	6915.2	2535.5	2443.1
20 Percentile	3670.6	3512.7	3524.2	3027.2	3483.1	3974.9	9186.5	21188.7	26438.7	9112.6	3096.5	3367.8
Minimum	1956.5	1957.7	1937.7	1674.8	1821.8	1880.0	2784.0	5172.6	5177.3	1816.1	1200.6	1721.3
Maximum	6616.8	5109.7	5760.0	4094.8	5771.1	7011.6	12030.7	29826.8	33973.3	16316.8	5530.0	5160.3
Clerk Fork below Thompson Falls Dam (cfs)												
Average	12944.4	13502.6	14612.0	15513.5	15653.5	14977.8	21908.6	48295.1	55450.7	26402.3	10828.5	10866.1
90 Percentile	9228.4	10064.3	11369.0	10487.8	10293.3	10243.5	11577.2	29138.2	25552.1	14887.9	7401.0	6825.6
80 Percentile	10638.2	11449.0	11982.6	13239.0	12379.1	10856.0	13715.2	31693.3	39641.1	16979.2	7911.2	8198.0
60 Percentile	11872.2	13276.2	13933.2	15458.6	14408.7	13052.0	16605.8	41484.6	46993.3	22528.4	9765.4	10101.0
50 Percentile	12744.5	14032.0	14835.5	15712.0	15834.7	14230.5	19487.5	48823.0	53915.5	26131.0	10810.5	10960.0
20 Percentile	15440.5	15448.2	16777.2	17567.3	19150.2	18170.6	32239.0	64594.4	71736.0	34001.2	13710.8	13247.3
Minimum	8378.0	8218.0	10317.0	9115.0	8622.0	6331.0	8701.0	15690.0	14112.0	9355.0	6545.0	5610.0
Maximum	21414.0	18859.0	22083.0	22234.0	22704.0	26590.0	41618.0	84106.0	90178.0	46042.0	15988.0	17733.6

*NOTE: Flows at Thompson Falls are slightly higher than those at Noxon. This is because flow records were obtained from MPC for Thompson Falls but were from records which were correlated to White Horse Rapids further downstream for the Noxon data shown here.

Clerk Fork below Noxon Rapids Dem (cfs)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average	12214.7	12814.5	14053.2	14651.4	15658.1	16563.0	22889.9	45557.6	55376.5	25166.2	10135.0	10254.6
90 Percentile	8799.2	9126.0	10738.7	10108.2	10004.0	10233.2	13107.2	27181.0	36958.0	13635.6	7211.2	6859.1
80 Percentile	9881.7	10490.3	11502.1	12237.7	12123.7	12825.7	14963.8	30519.4	39809.3	16809.6	7971.1	8164.1
60 Percentile	11278.3	12568.4	12974.1	14268.0	14541.4	14740.7	18774.7	40328.4	46355.0	21547.8	9178.8	9516.2
50 Percentile	12164.4	13044.5	13538.8	14943.7	15413.7	15702.1	20714.4	46708.0	51305.3	24698.5	10043.9	10358.6
20 Percentile	14155.1	15145.8	16128.8	16590.0	19491.0	19223.1	29070.7	59294.5	70325.9	32603.5	12130.1	12490.1
Minimum	6172.3	7106.7	9402.1	8481.6	9109.5	9341.9	4873.0	14457.7	13403.3	8329.7	6129.0	4838.3
Maximum	23154.0	19492.0	22094.8	22231.6	23475.0	32409.7	44116.7	74027.0	92590.0	42807.4	15031.9	16420.0

TABLE B-2. CLARK FORK WATER AVAILABILITY—DEMAND MODEL

Sprinkler Irrigation of Irrigable Lands, No Reservations

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork near Deer Lodge (cfs)												
Average	302.0	309.4	277.9	271.4	303.0	342.3	387.6	517.1	614.1	276.7	140.3	227.8
90 Percentile	210.4	240.2	205.3	206.8	206.4	260.9	244.7	244.3	186.6	67.3	49.1	126.7
80 Percentile	224.4	252.0	217.9	220.9	229.4	278.0	282.3	335.0	272.9	95.4	73.8	150.9
60 Percentile	268.7	275.8	250.8	233.8	260.6	301.4	331.2	441.6	490.6	191.4	116.2	194.9
50 Percentile	273.7	304.0	261.2	254.3	281.3	324.7	351.9	459.7	555.3	226.3	128.4	212.3
20 Percentile	369.5	354.5	319.1	318.8	390.3	419.7	499.1	740.3	891.0	413.0	184.1	291.0
Minimum	166.4	209.6	198.2	199.5	190.9	247.0	208.7	96.4	88.8	19.1	26.7	108.8
Maximum	548.2	501.5	573.3	490.0	613.6	586.0	780.2	1035.7	1547.1	936.5	501.9	432.6
Clark Fork above Confluence with Little Blackfoot River (cfs)												
Average	305.0	310.8	278.4	271.5	303.0	342.3	387.6	510.9	598.9	251.1	121.8	224.8
90 Percentile	213.4	241.6	205.8	206.9	206.4	260.9	244.7	238.1	171.4	41.5	30.7	123.7
80 Percentile	227.4	253.5	218.5	221.0	229.4	278.0	282.3	328.8	257.7	69.5	55.3	147.9
60 Percentile	271.7	277.2	251.3	233.9	260.6	301.4	331.2	435.4	475.3	165.6	97.7	191.9
50 Percentile	276.8	305.4	261.7	254.4	281.3	324.7	351.9	453.5	540.1	200.5	109.9	209.1
20 Percentile	372.6	355.9	319.4	318.9	390.3	419.7	499.1	734.1	875.7	387.2	165.7	288.0
Minimum	169.5	210.9	198.7	199.6	190.9	247.0	208.7	90.2	73.6	1.2	8.2	105.8
Maximum	551.3	503.0	573.9	490.1	613.6	586.0	780.2	1029.5	1531.9	910.7	483.4	429.6
Little Blackfoot River near Mouth (cfs)												
Average	75.3	69.1	66.3	61.5	90.8	119.6	225.3	670.9	515.8	118.6	47.7	64.4
90 Percentile	41.3	44.8	43.3	42.5	45.9	57.1	105.8	225.5	170.9	12.4	10.8	34.7
80 Percentile	51.4	50.1	43.7	45.1	54.4	66.0	123.0	381.6	275.8	57.2	24.6	43.4
60 Percentile	61.4	56.7	50.9	50.1	65.6	89.6	185.4	599.0	382.6	93.6	31.9	62.1
50 Percentile	72.1	63.7	55.8	53.6	72.0	108.0	222.5	646.8	394.5	99.4	42.3	66.9
20 Percentile	107.2	88.5	77.8	74.4	137.8	175.0	298.8	960.0	757.4	189.2	68.5	82.4
Minimum	36.6	40.7	38.3	37.1	33.0	45.0	89.0	90.8	57.0	10.4	1.8	18.4
Maximum	130.6	122.7	199.3	135.1	233.0	271.0	486.0	1456.8	1795.0	396.4	181.3	113.4

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork below Confluence with Little Blackfoot River (cfs)												
Average	380.3	379.9	344.7	333.0	393.8	461.8	612.9	1181.8	1114.7	369.7	169.4	289.2
90 Percentile	259.2	293.3	251.3	248.2	273.3	324.5	382.0	598.1	406.9	60.2	49.1	156.4
80 Percentile	278.7	306.3	269.8	265.2	283.3	342.1	436.9	745.6	572.1	128.0	76.8	203.9
60 Percentile	331.7	337.1	307.2	282.4	321.2	413.7	528.0	1095.4	885.3	268.4	142.1	249.4
50 Percentile	357.8	359.1	314.4	314.5	353.6	445.3	593.7	1175.2	977.3	304.9	152.2	274.4
20 Percentile	477.3	445.3	385.5	393.8	502.0	603.8	768.4	1516.1	1627.9	546.2	226.2	365.7
Minimum	206.1	283.8	241.1	244.7	223.9	294.8	297.7	194.8	147.3	13.5	15.5	127.2
Maximum	641.9	625.7	773.1	625.2	789.6	842.0	1248.2	2419.0	3326.9	1307.1	664.7	543.0
Clark Fork below Confluence with Gold Creek (cfs)												
Average	495.7	487.3	433.5	415.1	498.6	572.6	754.7	1475.4	1467.4	550.0	254.0	363.6
90 Percentile	344.6	376.5	321.5	309.8	336.4	431.0	471.5	635.2	422.7	110.6	91.7	204.0
80 Percentile	364.4	396.4	335.8	329.9	373.9	449.8	543.6	916.5	677.2	172.1	123.3	240.3
60 Percentile	442.8	432.0	380.0	355.6	414.7	500.6	648.4	1293.4	1182.5	368.5	216.9	311.8
50 Percentile	452.8	477.7	400.5	380.2	452.7	540.0	690.1	1341.0	1340.6	441.1	235.3	336.0
20 Percentile	594.5	560.3	501.3	496.3	646.9	711.1	961.6	2142.0	2124.9	851.5	322.7	473.0
Minimum	75.0	353.9	294.0	303.4	311.2	408.1	402.1	274.7	201.8	41.3	30.1	172.2
Maximum	896.6	786.9	896.5	745.0	1000.5	968.2	1503.4	2998.6	3761.7	1917.6	957.3	696.4
Clark Fork below Confluence with Flint Creek (cfs)												
Average	710.5	678.3	580.3	557.4	667.6	756.7	963.1	1709.2	1785.1	705.0	324.5	540.1
90 Percentile	493.7	524.4	428.6	407.7	448.6	566.4	596.8	729.3	508.6	142.3	115.7	301.5
80 Percentile	526.3	550.1	450.3	433.9	485.0	585.8	688.6	1052.4	805.8	217.2	155.2	378.5
60 Percentile	631.3	601.7	512.9	467.9	553.0	653.2	820.8	1484.2	1424.2	468.8	256.8	459.7
50 Percentile	645.4	663.0	533.3	500.3	611.5	724.5	861.0	1574.8	1614.6	560.6	291.6	495.7
20 Percentile	848.5	782.1	678.1	652.5	862.6	917.2	1233.2	2461.2	2660.6	1087.2	470.8	711.7
Minimum	391.5	495.5	392.3	399.3	415.0	537.0	509.0	314.8	242.6	53.5	38.6	254.7
Maximum	1279.5	1092.5	1195.3	1190.3	1334.0	1274.0	1903.0	3445.8	4531.6	2429.6	1197.6	1025.7

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork above Confluence with Rock Creek (cfs)												
Average	792.6	761.6	683.8	614.8	723.4	876.1	1183.3	1742.0	1887.0	843.2	379.2	632.4
90 Percentile	587.6	578.8	482.8	419.2	501.6	591.3	653.2	681.0	675.8	210.6	162.6	383.0
80 Percentile	611.2	614.9	539.7	456.3	539.1	636.8	801.6	1004.7	1042.7	325.6	233.3	448.2
60 Percentile	719.6	718.1	616.9	528.4	609.7	733.2	989.8	1375.5	1345.7	524.7	309.4	522.2
50 Percentile	756.8	741.8	654.1	565.4	632.0	813.8	1092.0	1515.6	1584.1	704.2	354.7	563.9
20 Percentile	968.4	861.2	754.6	754.8	909.2	1134.4	1426.6	2488.5	2907.0	1254.4	488.8	781.4
Minimum	445.8	547.5	377.6	283.3	423.1	467.4	512.4	406.4	332.3	104.2	107.7	337.4
Maximum	1369.8	1176.4	1367.4	1190.3	1322.0	1771.0	2443.1	3599.3	4662.4	2562.8	1246.1	1374.4
Clark Fork below Confluence with Rock Creek (cfs)												
Average	1075.6	1004.5	886.1	809.7	933.3	1119.3	1708.1	3491.7	4049.2	1646.5	717.5	919.2
90 Percentile	796.3	795.0	645.3	570.8	657.3	775.7	984.4	2071.8	1662.2	655.5	405.3	625.7
80 Percentile	852.6	829.3	715.4	628.5	729.6	837.5	1136.3	2324.8	2570.1	850.0	507.7	702.4
60 Percentile	961.2	942.5	802.6	717.2	797.8	943.2	1358.8	2981.1	3325.5	1321.3	618.8	799.6
50 Percentile	1068.3	992.0	871.1	758.5	837.5	1040.5	1560.8	3448.0	3641.3	1539.8	687.4	849.9
20 Percentile	1266.8	1126.0	1021.1	962.0	1187.2	1412.3	2198.9	4322.0	5984.5	2216.4	878.1	1108.8
Minimum	640.8	711.6	570.6	490.3	584.9	623.4	756.4	960.3	910.3	371.2	269.7	547.4
Maximum	1843.8	1606.4	1827.4	1459.3	1580.0	2121.0	3351.1	7250.4	8417.4	4470.8	1881.1	1761.4
Clark Fork above Confluence with Blackfoot River (cfs)												
Average	1081.0	1031.8	927.5	882.4	1005.6	1198.7	1789.4	3668.8	4182.7	1682.5	756.2	920.6
90 Percentile	796.7	820.8	700.1	620.8	708.4	826.4	1035.7	2134.0	1715.0	668.6	426.9	625.3
80 Percentile	853.0	848.3	734.4	684.9	788.2	893.0	1182.6	2466.1	2644.3	863.7	536.9	693.6
60 Percentile	961.6	965.2	842.4	803.7	857.8	993.6	1416.0	3132.3	3432.9	1349.1	674.6	799.2
50 Percentile	1071.7	1015.3	903.9	837.3	900.0	1121.5	1612.0	3628.5	3756.0	1557.8	723.3	849.5
20 Percentile	1272.0	1190.6	1051.6	1021.5	1276.0	1516.2	2305.8	4589.1	6249.7	2267.3	930.6	1118.6
Minimum	641.2	737.8	587.4	525.3	628.0	664.0	795.0	1007.5	936.5	391.2	282.8	547.0
Maximum	1844.2	1642.8	1884.4	1477.3	1714.0	2275.0	3535.0	7648.5	8769.5	4577.2	2006.8	1761.0

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork above Missoula and Bitterroot River												
Average	1783.6	1705.6	1551.7	1466.0	1645.3	1997.7	3789.2	8901.7	9650.9	3654.3	1618.1	1629.8
90 Percentile	1325.7	1358.6	1176.4	1098.1	1186.6	1334.2	1978.4	5587.4	4760.1	1684.1	1030.8	1224.6
80 Percentile	1429.8	1431.6	1244.2	1172.1	1248.4	1465.2	2246.6	6286.9	8386.7	2094.1	1193.8	1306.0
60 Percentile	1588.8	1573.0	1388.2	1312.1	1427.2	1634.0	2944.6	8249.5	8644.7	3185.3	1515.8	1438.6
50 Percentile	1771.2	1671.3	1459.4	1389.3	1479.0	1866.5	3261.5	9010.5	9035.0	3652.3	1645.8	1532.5
20 Percentile	1979.6	1931.4	1842.6	1748.9	2055.2	2521.2	5280.8	11391.5	13347.5	4913.0	1960.8	1868.8
Minimum	1092.2	1221.8	1098.4	1015.3	1119.0	1133.0	1570.0	2590.5	2108.5	1032.3	724.9	957.0
Maximum	2995.2	2855.8	3324.4	2546.3	3255.0	4124.0	7438.0	17223.5	18229.5	8690.2	3398.8	2866.0
Clark Fork below Missoula and Bitterroot River (cfs)												
Average	3087.3	2977.0	2701.8	2487.5	2773.1	3294.1	6334.0	16221.8	19444.6	6798.4	2520.8	2671.3
90 Percentile	2151.1	2306.7	2024.6	1898.9	1929.1	2214.1	3240.5	10327.6	9383.4	2552.9	1474.4	1862.2
80 Percentile	2456.2	2440.0	2068.4	1967.8	2164.5	2357.7	3673.1	11602.2	13483.3	3744.4	1865.9	1998.8
60 Percentile	2766.0	2639.3	2291.5	2177.9	2475.4	2890.1	5008.2	14550.1	16708.8	5848.4	2204.8	2272.5
50 Percentile	2878.3	2764.6	2437.5	2291.7	2572.7	3195.6	5783.0	15523.1	19196.1	6846.5	2486.3	2435.2
20 Percentile	3678.8	3516.5	3525.6	3027.5	3483.1	3974.9	9186.5	21172.2	26398.2	9043.9	3047.3	3359.8
Minimum	1964.7	1961.5	1939.1	1675.1	1821.8	1880.0	2784.0	5156.1	5136.8	1747.4	1151.4	1713.3
Maximum	6624.9	5113.5	5761.4	4095.1	5771.1	7011.6	12030.7	29810.3	33932.8	16248.0	5480.8	5852.3
Clark Fork below Thompson Falls Dam (cfs)												
Average	12952.3	13506.3	14613.3	15513.8	15653.5	14977.8	21908.6	48278.4	55409.9	26333.7	10779.3	10858.1
90 Percentile	9236.5	10068.0	11370.4	10488.1	10293.3	10243.5	11577.2	29121.7	25511.6	14819.1	7351.8	6817.6
80 Percentile	10646.3	11452.8	11984.0	13239.3	12379.1	10856.0	13715.2	31677.9	39600.6	16910.4	7862.0	8190.0
60 Percentile	11880.3	13280.0	13934.6	15458.9	14408.7	13052.0	16605.8	41468.1	46952.8	22459.6	9716.2	10093.0
50 Percentile	12752.6	14035.7	14836.9	15712.3	15834.7	14230.5	19487.5	48806.5	53875.0	26062.2	10761.3	10952.0
20 Percentile	15448.6	15449.7	16778.6	17567.5	19150.2	18170.6	32239.0	64577.9	71695.3	33932.4	13661.6	13239.3
Minimum	8386.1	8221.8	10318.4	9115.3	8622.0	6331.0	8701.0	15673.5	14071.5	9286.2	6495.8	5602.0
Maximum	21422.1	18862.8	22084.4	22234.3	22704.0	26590.0	41618.0	84089.4	90137.3	45973.2	15938.8	17725.2

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork below Noxon Rapids Dam (cfs)												
Average	12222.6	12818.2	14054.5	14651.6	15658.1	16563.0	22889.9	45541.0	55335.7	25097.6	10085.8	10246.8
90 Percentile	8807.4	9129.8	10740.1	10108.4	10004.0	10233.2	13107.2	27164.5	36917.5	13566.9	7162.0	6850.9
80 Percentile	9889.9	10494.1	11503.5	12237.9	12123.7	12825.7	14983.8	30502.9	39768.8	16740.9	7921.9	8156.1
60 Percentile	11286.4	12572.2	12975.5	14268.2	14541.4	14740.7	18774.7	40311.9	46314.5	21479.1	9129.6	9508.2
50 Percentile	12168.5	13048.3	13540.2	14944.0	15413.7	15702.1	20714.4	46691.6	51264.8	24629.8	9994.7	10350.7
20 Percentile	14163.3	15149.6	16130.2	16590.3	19491.0	19223.1	29070.7	59278.0	70285.2	32534.8	12080.9	12482.1
Minimum	6180.4	7110.5	9403.4	8481.9	9109.5	9341.9	4873.0	14441.2	13362.8	8260.9	6082.3	4830.3
Maximum	23162.1	19495.8	22096.2	22231.9	23475.0	32409.7	44116.7	74010.4	92549.3	42738.7	14982.7	16411.6

TABLE B-3. CLARK FORK WATER AVAILABILITY—DEMAND MODEL

With Only GCD's Proposed North Fork of Willow Creek Project

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork above Confluence with Rock Creek (cfs)												
Average	789.9	760.6	683.8	615.0	723.7	875.2	1176.7	1727.9	1916.1	908.8	432.0	646.6
90 Percentile	587.1	577.6	481.9	419.0	501.6	591.3	647.0	686.4	714.3	276.3	213.7	391.2
80 Percentile	609.3	613.2	538.9	456.3	539.1	636.8	801.6	993.3	1081.4	391.8	281.5	461.6
60 Percentile	714.3	717.0	617.2	528.4	809.7	733.2	989.8	1364.5	1384.4	580.5	364.7	533.4
50 Percentile	754.5	741.1	654.0	565.2	632.0	810.2	1089.6	1504.6	1609.3	770.0	406.6	581.3
20 Percentile	965.6	860.2	754.6	754.6	909.2	1133.7	1405.7	2465.7	2937.5	1320.5	550.7	793.6
Minimum	439.5	546.0	377.8	283.1	423.1	467.4	512.4	403.5	373.7	162.5	154.7	343.7
Maximum	1365.6	1174.6	1374.8	1190.2	1322.0	1771.0	2422.3	3615.0	4659.2	2628.5	1297.5	1394.7
Clark Fork below Confluence with Rock Creek (cfs)												
Average	1073.0	1003.5	896.2	809.8	933.6	1118.4	1701.4	3477.6	4078.3	1712.2	770.2	933.4
90 Percentile	793.8	794.4	644.4	570.7	657.3	775.7	984.4	2065.6	1700.9	721.4	452.4	833.9
80 Percentile	851.4	827.6	715.0	628.6	729.6	837.5	1136.3	2321.5	2608.9	916.2	555.8	711.7
60 Percentile	957.9	941.5	802.9	717.0	797.8	943.2	1358.8	2972.7	3364.2	1387.2	673.1	812.1
50 Percentile	1064.3	991.2	871.5	758.4	837.5	1040.5	1562.1	3422.4	3680.1	1605.5	741.7	865.1
20 Percentile	1265.6	1125.2	1021.1	962.0	1190.3	1414.5	2175.1	4299.7	6005.7	2282.1	934.6	1123.1
Minimum	634.5	709.9	570.6	480.1	584.9	623.4	756.4	976.0	951.7	429.5	316.7	554.9
Maximum	1839.6	1604.6	1834.8	1459.2	1580.0	2121.0	3330.3	7228.3	8414.2	4536.5	1932.5	1781.7
Clark Fork above Confluence with Blackfoot River (cfs)												
Average	1078.0	1030.6	927.5	882.5	1005.8	1197.8	1782.8	3655.4	4213.6	1751.2	811.1	935.1
90 Percentile	793.8	819.7	699.2	620.6	708.4	826.4	1035.7	2130.0	1755.5	737.4	476.1	633.9
80 Percentile	851.4	846.5	733.8	684.8	788.2	893.0	1190.6	2463.6	2684.8	932.9	587.1	703.3
60 Percentile	957.9	964.0	842.4	803.7	857.8	993.6	1416.0	3124.7	3473.4	1418.0	730.1	812.1
50 Percentile	1069.4	1014.3	904.0	837.1	900.0	1121.5	1613.3	3611.4	3796.5	1626.5	779.8	865.1
20 Percentile	1270.1	1190.1	1051.9	1021.4	1279.1	1518.4	2282.0	4581.3	6272.7	2336.0	985.9	1139.1
Minimum	634.5	735.9	587.4	525.1	628.0	664.0	795.0	1024.0	979.6	452.5	332.0	554.9
Maximum	1839.6	1640.9	1891.7	1484.4	1714.0	2275.0	3514.2	7627.2	8768.1	4646.0	2060.4	1781.7

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork above Missoula and Confluence with Bitterroot River (cfs)												
Average	1780.6	1704.4	1551.7	1466.1	1645.5	1896.8	3782.5	8888.3	9681.8	3723.0	1873.1	1644.4
90 Percentile	1323.5	1357.6	1176.4	1097.9	1186.8	1334.2	1978.4	5586.6	4800.6	1752.9	1081.0	1232.8
80 Percentile	1428.8	1428.7	1243.3	1172.0	1248.4	1465.2	2246.6	6284.4	6427.2	2163.4	1244.4	1318.7
60 Percentile	1587.5	1571.7	1388.2	1311.9	1427.2	1634.0	2944.6	8236.0	8681.9	3254.0	1572.0	1459.3
50 Percentile	1766.4	1669.4	1459.5	1389.2	1478.0	1866.5	3257.3	8988.2	9074.7	3721.0	1700.4	1550.8
20 Percentile	1876.8	1930.5	1842.6	1748.8	2059.8	2523.4	5258.1	11391.7	13367.1	4981.8	2016.4	1881.4
Minimum	1085.5	1219.9	1098.4	1015.1	1118.0	1133.0	1570.0	2607.0	2151.6	1101.0	774.1	964.9
Maximum	2994.5	2855.8	3331.7	2553.4	3255.0	4108.0	7417.2	17202.2	19228.1	8759.0	3452.4	2886.7
Clark Fork below Missoula and Bitterroot River (cfs)												
Average	3084.3	2975.8	2701.8	2487.6	2773.3	3293.3	6327.4	16208.5	19475.5	6867.1	2575.7	2685.9
90 Percentile	2147.6	2305.6	2024.6	1898.7	1829.1	2214.1	3240.5	10320.4	9423.9	2621.8	1523.6	1870.6
80 Percentile	2453.1	2437.7	2068.4	1967.7	2164.5	2357.7	3673.1	11597.6	13523.8	3813.7	1917.5	2008.8
60 Percentile	2762.6	2838.3	2291.5	2178.0	2475.4	2890.1	5008.2	14531.5	16736.1	5917.8	2258.5	2283.9
50 Percentile	2873.9	2763.9	2437.1	2291.5	2572.7	3195.6	5771.7	15498.5	19236.6	6915.2	2541.5	2458.3
20 Percentile	3675.6	3515.5	3525.1	3027.3	3486.2	3977.1	9162.7	21142.5	26404.2	9112.6	3108.1	3373.6
Minimum	1958.0	1958.6	1938.3	1674.8	1821.8	1880.0	2784.0	5172.6	5179.9	1816.1	1200.6	1721.2
Maximum	6624.3	5113.6	5768.7	4102.2	5771.1	7011.6	12009.9	29789.0	33957.6	16316.8	5534.4	5173.0
Clark Fork below Thompson Falls Dam (cfs)												
Average	12949.3	13505.1	14613.4	15513.9	15653.7	14978.9	21902.0	48265.1	55440.9	26402.5	10834.2	10872.6
90 Percentile	9233.8	10067.5	11370.3	10487.9	10293.3	10243.5	11577.2	29103.8	25552.1	14888.4	7403.1	6830.5
80 Percentile	10644.9	11452.2	11983.2	13239.1	12379.1	10856.0	13715.2	31673.0	39641.1	16979.5	7913.9	8203.5
60 Percentile	11879.2	13279.5	13934.3	15458.7	14408.7	13052.0	16616.6	41458.5	46989.3	22528.4	9765.9	10114.5
50 Percentile	12749.3	14033.8	14836.5	15712.3	15834.7	14230.5	18480.1	48807.7	53915.3	26131.4	10818.3	10973.5
20 Percentile	15443.7	15449.1	16778.9	17567.5	19154.8	18172.0	32225.5	64565.9	71718.4	34001.2	13720.6	13255.0
Minimum	8383.9	8220.9	10318.7	9115.3	8622.0	6331.0	8701.0	15690.0	14114.6	9355.0	6556.4	5608.7
Maximum	21421.5	18862.9	22091.7	22234.1	22704.0	26580.0	41618.0	84081.4	90149.1	46042.0	16000.3	17734.2

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Clark Fork below Noxon Rapids Dam (cfs)												
Average	12219.7	12817.1	14054.5	14651.7	15658.3	16562.1	22883.3	45527.7	55366.8	25166.3	10140.7	10261.2
90 Percentile	8802.0	9129.2	10740.0	10108.3	10004.0	10233.2	13107.2	27158.2	36858.0	13636.4	7213.2	6859.3
80 Percentile	9888.4	10493.1	11502.5	12237.8	12123.7	12825.7	14963.8	30492.3	39809.3	16809.9	7973.4	8170.0
60 Percentile	11285.3	12571.3	12975.4	14268.2	14541.4	14740.7	18774.7	40281.9	46351.0	21547.8	9186.5	9531.0
50 Percentile	12167.6	13047.6	13539.6	14944.0	15413.7	15702.1	20711.5	46676.9	51290.9	24698.5	10050.5	10369.6
20 Percentile	14158.0	15148.3	16130.4	16590.2	19494.1	19223.1	29057.6	59261.3	70308.9	32603.5	12138.3	12495.5
Minimum	6178.2	7109.6	9403.8	8481.9	9109.5	9341.9	4873.0	14457.7	13405.9	8329.7	6129.4	4837.0
Maximum	23161.5	19495.9	22103.5	22231.7	23475.0	32409.7	44095.9	74002.4	92567.9	42807.4	15036.3	16420.6

TABLE 8-4. FLINT CREEK WATER AVAILABILITY—DEMAND MODEL

Existing Conditions

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Lower Willow Creek at Mouth (cfs)												
Average	25.3	14.5	8.0	5.6	5.0	6.4	19.7	95.3	37.9	13.5	16.9	32.9
90 Percentile	20.6	12.1	7.4	5.6	5.0	5.0	5.0	26.6	10.1	5.7	7.4	24.0
80 Percentile	23.5	13.5	7.8	5.6	5.0	5.0	5.0	63.3	10.1	6.9	9.3	27.1
60 Percentile	26.0	14.8	8.0	5.6	5.0	5.0	5.0	78.90	10.1	11.0	13.8	32.2
50 Percentile	28.2	16.1	8.2	5.6	5.0	5.0	5.0	94.6	16.4	14.2	21.6	35.4
20 Percentile	28.0	15.8	8.4	5.6	5.0	5.0	35.0	141.9	69.8	19.5	22.9	40.0
Minimum	5.0	5.0	5.0	5.0	5.0	5.0	5.00	14.6	4.9	4.8	5.3	13.4
Maximum	30.4	17.0	9.0	5.6	5.0	27.7	88.0	250.2	198.5	19.5	37.7	47.7
Flint Creek near Mouth (cfs)												
Average	197.3	149.2	113.2	93.3	99.0	111.5	166.8	405.6	407.9	87.5	55.2	168.1
90 Percentile	144.6	113.6	82.7	64.8	69.0	74.0	95.2	227.8	113.7	30.0	34.8	97.8
80 Percentile	154.3	119.2	89.5	72.8	78.5	84.0	111.6	270.7	196.3	33.7	38.1	119.9
60 Percentile	177.7	133.2	102.7	86.4	86.0	100.8	132.4	339.2	289.5	36.3	41.0	153.7
50 Percentile	202.1	156.6	126.8	98.1	92.8	123.5	160.3	410.9	380.1	37.9	59.3	187.8
20 Percentile	235.6	178.2	132.4	114.1	121.9	145.1	212.8	530.6	679.1	127.3	63.0	226.2
Minimum	121.7	104.7	77.5	53.5	53.6	61.1	78.0	165.5	45.4	22.6	20.8	57.1
Maximum	298.2	217.8	200.0	146.8	152.2	166.7	352.3	995.6	952.1	515.4	228.5	276.6

With GCD's Proposed North Fork of Lower Willow Creek Project

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Lower Willow Creek at Mouth (cfs)												
Average	28.9	16.9	9.3	5.9	5.2	5.5	13.0	65.5	28.3	13.9	25.6	38.7
90 Percentile	23.0	13.3	7.7	5.7	5.0	5.0	5.0	14.8	10.1	6.7	8.4	22.9
80 Percentile	27.1	15.4	8.4	5.7	5.0	5.0	5.0	39.5	10.1	8.5	11.9	29.3
60 Percentile	31.0	17.4	9.2	5.7	5.0	5.0	5.0	50.8	10.1	12.4	25.6	36.2
50 Percentile	32.9	18.3	9.4	5.7	5.0	5.0	5.0	62.0	10.1	13.8	30.3	40.1
20 Percentile	34.0	18.9	9.9	5.9	5.0	5.0	19.6	98.2	42.3	19.5	37.0	49.4
Minimum	5.0	5.0	5.0	5.0	5.0	5.0	5.0	14.6	7.4	4.9	5.4	13.3
Maximum	34.0	18.9	17.7	13.0	12.7	22.7	66.2	212.4	158.6	19.5	42.1	55.1

Flint Creek near Mouth (cfs)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average	202.2	151.7	114.5	93.7	99.2	110.6	160.1	375.7	398.3	87.7	61.0	174.7
90 Percentile	148.3	116.2	84.2	64.9	69.0	74.0	95.2	210.2	113.7	30.6	35.4	100.2
80 Percentile	158.6	121.8	90.2	72.9	78.5	84.0	111.6	247.5	195.1	33.7	39.5	123.1
60 Percentile	183.0	134.5	104.0	86.7	86.0	90.7	129.9	315.6	289.2	36.8	46.9	160.9
50 Percentile	206.2	160.9	121.9	98.2	92.8	123.5	149.8	366.9	380.1	37.8	48.5	183.7
20 Percentile	241.1	181.1	133.6	114.4	122.3	144.6	196.1	489.8	655.5	127.3	70.9	230.6
Minimum	123.2	105.9	77.8	53.6	53.6	61.1	78.0	165.5	48.0	22.6	20.8	55.8
Maximum	301.8	219.7	208.7	154.2	152.2	167.7	330.5	957.8	910.2	515.4	232.9	289.3

TABLE B-5. RESERVOIR STORAGE AT END OF MONTH

Existing Conditions

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Lower Willow Creek Reservoir (1000 acre-feet)												
Average	.344	.731	1.074	1.313	1.853	2.523	3.872	4.506	3.881	.484	.000	.000
Median	.26	.60	.99	1.15	1.48	2.16	4.47	4.65	4.62	.43	.00	.00
80 Percentile	.16	.44	.76	.89	1.12	1.58	2.79	4.65	3.01	.00	.00	.00
60 Percentile	.21	.56	.84	1.06	1.43	2.03	3.89	4.65	4.18	.21	.00	.00
40 Percentile	.30	.66	1.04	1.26	1.64	2.46	4.65	4.65	4.65	.43	.00	.00
20 Percentile	.49	.93	1.40	1.74	2.45	3.56	4.65	4.65	4.65	.73	.00	.00
Maximum	1.84	2.29	3.01	3.55	4.58	4.65	4.65	4.65	4.65	2.61	.00	.00
Minimum	.00	.22	.24	.35	.54	.74	1.79	1.80	.00	.00	.00	.00

With GCO's Proposed North Fork of Willow Creek Project

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Proposed North Fork of Lower Willow Creek Reservoir (1000 acre-feet)												
Average	.099	.139	.195	.252	.353	.520	1.073	2.756	3.080	1.108	.027	.025
Median	.00	.00	.09	.15	.22	.37	.95	2.67	3.28	.50	.00	.00
80 Percentile	.00	.00	.01	.03	.05	.18	.47	2.07	1.34	.00	.00	.00
60 Percentile	.00	.00	.07	.12	.18	.32	.78	2.58	2.76	.00	.00	.00
40 Percentile	.00	.06	.10	.16	.26	.46	1.09	2.94	3.92	.91	.00	.00
20 Percentile	.08	.16	.26	.33	.44	.68	1.53	3.68	4.95	2.42	.00	.00
Maximum	1.65	1.73	1.80	1.86	2.05	2.22	3.46	4.95	4.95	4.23	.96	.91
Minimum	.00	.00	.00	.00	.00	.00	.00	.09	.00	.00	.00	.00
Lower Willow Creek Reservoir (1000 acre-feet)												
Average	.692	1.038	1.327	1.524	1.952	2.510	3.710	4.514	4.105	2.329	.804	.383
Median	.31	.67	.98	1.16	1.82	2.37	3.87	4.65	4.01	2.99	.02	.00
80 Percentile	.19	.46	.75	.87	1.09	1.44	2.53	4.65	4.00	1.47	.00	.00
60 Percentile	.26	.60	.91	1.04	1.31	2.01	3.56	4.65	4.00	2.88	.00	.00
40 Percentile	.65	1.12	1.38	1.61	2.09	2.76	4.44	4.65	4.65	2.99	.40	.03
20 Percentile	1.41	1.76	1.99	2.18	2.66	3.52	4.65	4.65	4.65	2.99	1.89	.85
Maximum	2.61	3.44	4.30	4.65	4.65	4.65	4.65	4.65	4.65	2.99	2.98	2.00
Minimum	.00	.22	.24	.35	.54	.74	1.78	3.00	.77	.00	.00	.00

TABLE B-6. OUTFLOW FROM GCD'S PROPOSED NORTH FORK OF LOWER WILLOW CREEK PROJECT (CFS)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average	2.15	2.42	1.95	2.07	2.16	1.95	2.10	3.85	12.92	35.60	18.98	1.88
Median	1.95	2.18	1.95	1.95	2.16	1.95	2.02	1.95	12.44	40.50	9.60	1.68
80 Percentile	1.95	2.02	1.95	1.95	2.16	1.95	2.02	1.95	2.02	23.26	0.98	1.34
60 Percentile	1.95	2.02	1.95	1.95	2.16	1.95	2.02	1.95	9.41	38.22	2.60	1.51
40 Percentile	2.11	2.52	1.95	1.95	2.16	1.95	2.02	1.95	17.48	44.08	16.10	1.85
20 Percentile	2.44	2.86	1.95	1.95	2.16	1.95	2.02	1.95	22.02	46.03	40.82	2.52
Maximum	4.07	3.53	2.76	8.99	2.34	2.11	4.71	46.03	31.76	55.30	58.06	4.20
Minimum	0.81	2.02	0.65	1.30	2.16	1.95	2.02	1.95	2.02	0.98	0.65	0.50

APPENDIX C

WILDLIFE, VEGETATION, AND FISH SPECIES IN THE UPPER CLARK FORK

TABLE C-1 Fish species in the upper Clark Fork basin by stream reach.

Stream Reach	Gamefish: Cutthroat trout	Westslope cutthroat trout	Rainbow trout	Brown trout	Bull trout	Brook trout	Bull/Brook hybrid	Mountain whitefish	Largemouth bass	Other fish: Sculpin	Shorthead sculpin	Longnosed dace	Largescale sucker	Longnose sucker	Redside shiner	Number of trout per mile (dominant game fish in parenthesis)	Comments
Clark Fork Reach 1 (Warm Springs-Garnson)	●		●	●	●	●		●		●			●	●	●	143-2334 (brown trout)	The first 2-3 miles of stream below the Warm Springs treatment ponds has developed a very good brown trout fishery since 1972 when no trout were present. Sculpins, a forage fish, are found in this reach. Trout numbers decrease as one moves downstream from the treatment ponds where metals are removed
Clark Fork Reach 2 (Garnson-Drummond)	●		●	●	●			●	●	●			●	●		127-499 (brown trout)	Water quality is degraded from metals contamination.
Clark Fork Reach 3 (Drummond-Rock Creek)	●		●	●	●			●	●				●	●		48-123 (brown trout)	Sculpins, a forage fish, are absent from this reach. Northern squawfish, yellow perch, and pumpkinseed are found rarely.
Clark Fork Reach 4 (Rock Creek-Milltown Dam)	●		●	●	●			●	●	●			●	●		309-440 (brown trout)	Clean water from Rock Creek appears to dilute the dissolved metals. Northern squawfish, yellow perch, and pumpkinseed are found rarely
Warm Springs Creek (upper)	●				●											502 > than 6" (brown trout)	Very good fish habitat. Fish reproduce naturally in this reach
Warm Springs Creek (lower)				●				●						●		492 (brown trout)	This reach is important because brown trout and mountain whitefish from the Clark Fork use this reach to spawn. Water quality in the Clark Fork is not conducive to spawning
Barker Creek		●	●		●	●								●		(bull trout)	Steep gradient stream probably used for spawning by bull trout from Warm Springs Creek. No population estimate available
Cable Creek	●		●		●	●				●						1,197 (brook trout)	Only self-sustaining population of rainbow trout in the Warm Springs Creek drainage. Brook trout most abundant, bull and cutthroat trout are rare. Provides clean water to Warm Springs Creek.
Storm Lake Creek	●				●	●										145	Provides clean water to Warm Springs Creek. Historically, flows have been diverted to Silver Lake by AMC.
Twin Lakes Creek		●			●	●	●									880 > than 6" (cutthroat and bull trout)	Fish from Warm Springs Creek may spawn here. Very good water quality
Lost Creek	●			●	●	●		●						●	●	880 (brown trout)	Brown trout are the most numerous trout present. Sampling in the fall indicates a large number of brown trout and mountain whitefish from the Clark Fork may be using Lost Creek for spawning
Racetrack Creek (upper)	●			●		●		●		●						?	Cutthroat trout are found throughout this reach while whitefish and brown trout are found in the lower end. Fish are generally small (less than 10") due to low nutrient levels. A popular fishing stream
Racetrack Creek (lower)	●			●		●		●		●						585 (brown trout)	Brown trout from the Clark Fork may use this reach for spawning

Sources. DFWP 1986b, MNRIS 1987, Thomas and Workman 1986

TABLE C-1 Fish species in the upper Clark Fork basin by stream reach.

Stream Reach	Gamefish									Other fish							
	Cutthroat trout	Westslope cutthroat trout	Rainbow trout	Brown trout	Bull trout	Brook trout	Bull/Brook hybrid	Mountain whitefish	Largemouth bass	Sculpin	Shorthead sculpin	Longnosed dace	Largescale sucker	Longnose sucker	Redside shiner	Number of trout per mile (dominant game fish in parenthesis)	Comments
Dempsey Creek	●			●		●										776-880	Cutthroat trout rare, brook trout common, and brown trout abundant
Little Blackfoot River (upper)		●	●	●	●	●	●	●		●						645	A productive fishery in a smaller stream
Little Blackfoot River (lower)	●		●	●	●	●		●		●	●			●		906 (brown trout)	The stream has been disturbed but the study reach has a substantial population of brown trout. Shorthead sculpins are a species of special concern because of their limited distribution
Snowshoe Creek	●			●				●		●			●			475 (brown trout) > than 6"	Cutthroat trout are most numerous in the upper reaches of the stream while brown trout are more numerous in the lower stream reaches. The lower reaches are low-gradient and appear to receive a considerable amount of groundwater inflow
Dog Creek		●		●	●	●		●								541 (brown trout)	In an upstream section, 218 brown trout per mile were found while a lower reach had a population of 541 trout per mile, including all trout species. Genetically pure westslope cutthroat trout were found in this stream
Gold Creek	●	?		●		●		●								370 in summer, 1,180 in fall (brown trout)	An important spawning stream. Brown trout and whitefish probably from the Clark Fork use this stream for spawning. Tributaries to the Clark Fork used for spawning are not common in this reach of the Clark Fork
Flint Creek (upper)	●		●	●	●	●		●		●				●		877	A diverse fish population in a broad valley with extensive irrigation
Flint Creek (lower)	●			●	●			●		●				●		567 (brown trout)	Fishery appears limited by siltation caused by bank erosion and turbid irrigation return flows
Boulder Creek	●	?		●	●											317	Reaches above Princeton have a sparse trout population, while trout are more abundant near the mouth. Bull trout are reported to ascend the stream for spawning. The cutthroat appear to be pure westslope species
North Fork of Flint Creek	●		●		●	●											One of two tributaries to Georgetown Lake used for spawning. Rainbow-cutthroat hybrids, rainbow trout, and brook trout are known to spawn here
Stuart Mill			●			●											This 1/3-mile long spring creek is used for spawning by Kokanee salmon, brook trout, and rainbow trout from Georgetown Lake in large numbers. Young fish move down into the lake
Harvey Creek		●	●	●	●	●				●		●	●			127	Mostly small trout in this creek. Spawning runs from the Clark Fork seem to be cut off by an irrigation diversion near the mouth of the creek
North Fork Lower Willow Creek		●				●										121/500 feet	A small creek with an abundant population of pure strain west slope cutthroat trout

Sources: DFWP 1986b, MNRIS 1987, Thomas and Workman 1986

TABLE C-2 Typical animals and waterfowl use found along Clark Fork tributaries affected by the reservation process. Table C-4 lists scientific names.

	Big Game							Furbearers						Waterfowl Use				Gamebirds			Winter Range		
Stream	Whitetail	Mule Deer	Moose	Elk	Black Bear	Bighorn	Mountain Goat	Beaver	Mink	Muskrat	Red Fox	Raccoon	Marten	Limited	Moderate	Substantial	Nesting	Mountain Grouse[1]	Gray Partridge	Pheasant	Deer	Elk	Comments
Warm Springs Creek (upper)	●	●	●	●				●	●	●								●				●	Critical elk range.
Warm Springs Creek (lower)	●							●	●	●	●					●			●	●			Provides open water when other waters are ice covered
Barker Creek		●	●	●				●	●	●				●				●					
Cable Creek	●	●	●	●				●	●	●					●			●					
Storm Lake Creek								●	●	●								●					Waterfowl use not evaluated.
Twin Lakes Creek	●	●	●	●				●	●	●				●				●					
Lost Creek	●	●	●	●		●		●	●	●	●					●	●	●	●			●	Critical elk range.
Racetrack Creek (upper)		●	●	●				●	●	●			●	●			●	●					Lynx are also present.
Racetrack Creek (lower)	●	●	●	●				●	●	●					●			●	●				
Dempsey Creek	●	●	●	●				●	●	●				●				●	●			●	Critical elk range.
Little Blackfoot River (upper)	●	●	●	●	●			●	●	●					●			●					Waterfowl frequently observed on beaver ponds.
Little Blackfoot River (lower)	●	●			●			●	●	●					●		●	●					Franklin's grouse not present. High density of nesting red-tailed hawks.
Snowshoe Creek	●	●		●				●	●	●					●		●	●	●				Groundwater inflow extends open water season.
Dog Creek		●	●	●				●	●	●					●		●	●					Waterfowl use in meadow and beaver pond sections.
Gold Creek	●	●		●				●	●	●		●		●							●		Deer winter range found near the middle 2 miles
Flint Creek (upper)	●	●	●	●				●	●	●				●				●	●				
Flint Creek (lower)	●	●	●	●				●	●	●						●	●	●	●				
Boulder Creek	●	●	●	●			●	●	●					●				●					
North Fork Flint Creek	●	●	●	●											●			●					Waterfowl use lower reach.
Stuart Mill Creek	●		●						●	●						●	●	●					Provides open water during cold weather periods.
Harvey Creek	●							●	●	●		●			●								Groundwater inflow extends open water season.
North Fork Lower Willow Creek Reservoir Site								●															Deer winter range 1.5 miles to southwest.

[1]Mountain grouse category includes ruffed grouse, blue grouse, and Franklin's grouse
Sources DFWP, 1986b; Flath, 1987; Froenfelker, 1987, McCleerey, 1987; Nielson, 1987, Murphy, 1987

TABLE C-3 Typical plants and condition of vegetation found along Clark Fork tributaries affected by the reservation process. Table C-4 lists scientific names.

	Trees						Shrubs			Herbs		Vegetation condition			
Stream	Cottonwood	Aspen	Spruce	Subalpine fir	Lodgepole	Douglas-fir	Willow	Alder	Ninebark	Sedges	Grasses	Poor	Fair	Good	**Comments**
Warm Springs Creek (upper)					●		●		●	●	●			●	Vegetation is well established
Warm Springs Creek (lower)							●	●			●		●		Some riparian communities have been damaged by rapid flows and erosion due to nearby road construction
Barker Creek		●	●				●	●						●	Trees and shrubs grow in dense stands.
Cable Creek													●		Extensive meadows near mouth. Lower sections are heavily grazed by livestock
Storm Lake Creek		●	●				●	●							
Twin Lakes Creek		●	●				●	●							Flows through forested areas.
Lost Creek													●		Vegetation scarce in upper section. Condition improves to well preserved near the mouth
Racetrack Creek (upper)														●	Abundant riparian vegetation.
Racetrack Creek (lower)													●		Vegetation scarce in upper section Condition improves to well preserved near the mouth
Dempsey Creek	●						●	●							Cottonwoods found on lower reaches
Little Blackfoot River (upper)			●	●			●	●							
Little Blackfoot River (lower)	●						●								
Snowshoe Creek												●			Riparian vegetation is severely restricted
Dog Creek															Meadow sections present
Gold Creek															No information available.
Flint Creek (upper)							●	●							Shrub thickets are scattered. Development of continuous shrub stands prevented by livestock grazing
Flint Creek (lower)							●	●							Shrub thickets are scattered and restricted by livestock grazing
North Fork Flint Creek							●	●							
Stuart Mill Creek							●	●		●					
Harvey Creek															No information available.
Boulder Creek					●	●	●		●	●					Douglas-fir and ninebark grow on north aspects Douglas-fir and lodgepole grow on south aspects Willows and sedges near stream.
North Fork Lower Willow Creek Reservoir Site															Composed of prairie grassland, wet meadow and stands of willow

Sources: DFWP, 1986b; Murphy, 1987; Nielson, 1987

Table C-4. Common and Scientific Names of Plants and Animals Discussed in the Text

Common name	Scientific name
Plants	
Smooth brome	*Bromus inermis*
Meadow foxtail	*Alopecurus pratensis*
Redtop	*Agrostis alba*
Kentucky bluegrass	*Poa pratensis*
Willow	*Salix* spp.
Cottonwood	*Populus* spp.
Sedge	*Carex* spp.
River birch	*Betula occidentalis*
Tufted hairgrass	*Deschampsia caespitosa*
Red osier dogwood	*Cornus stolonifera*
Rose	*Rosa* spp.
Chokecherry	*Prunus virginiana*
Quackgrass	*Agropyron repens*
Ponderosa pine	*Pinus ponderosa*
Rocky Mountain juniper	*Juniperus scopulorum*
Snowberry	*Symphoricarpos albus*
Gooseberry	*Ribes* spp.
Mountain maple	*Acer glabrum*
Elderberry	*Sambucus* spp.
Alder	*Alnus* spp.
Aspen	*Populus tremuloides*
Spruce	*Picea* spp.
Subalpine fir	*Abies lasiocarpa*
Ninebark	*Physocarpus* spp.
Lodgepole pine	*Pinus contorta*
Animals	
White-tailed deer	*Odocoileus virginianus*
Mule deer	*Odocoileus hemionus*
Beaver	*Castor canadensis*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethicus*
Elk	*Cervus canadensis*
Osprey	*Pandion haliaetus*
Canada goose	*Branta canadensis*
Blue grouse[a]	*Dendragapus obscurus*
Franklin's grouse[a]	*Canachites canadensis*
Ruffed grouse[a]	*Bonasa umbellus*
Moose	*Alces alces*
Red fox	*Vulpes fulva*
Gray partridge	*Perdix perdix*
Ring-necked pheasant	*Phasianus colchicus*
Lynx	*Lynx canadensis*
Marten	*Martes americana*
Black bear	*Ursus americanus*
Red-tailed hawk	*Buteo jamaicensis*
Mountain goat	*Oreamnos americanus*
Raccoon	*Procyon lotor*

[a] Called "mountain grouse" in the text.

APPENDIX D

RESOURCE BASELINE DATA

Table D-1. Percentage of water samples exceeding B-1 acute toxicity criteria for copper in the Clark Fork between the Little Blackfoot River and Milltown Dam, 1975-1983.

Month	No. Samples	Percent of Samples Exceeding B-1 Acute Copper Criteria[a]
January	3	0
February	5	0
March	4	75
April	2	50
May	12	67
June	1	100
July	19	0
August	13	0
September	7	0
October	4	0
November	4	0
December	0	-

Source: DFWP 1986.

[a] Updated EPA criteria are more stringent than those used in these calculations; thus it is possible that a slightly greater percentage of samples will exceed the updated criteria.

Table D-2. Percentage of water samples exceeding B-1 acute toxicity criteria for copper in the Clark Fork between Warm Springs Creek and the Little Blackfoot River 1975-1983.

Month	No. Samples	Percent of Samples Exceeding B-1 Acute Copper Criteria[a]
January	11	9
February	9	33
March	10	30
April	7	71
May	10	90
June	5	80
July	16	44
August	34	0
September	11	0
October	8	0
November	18	0
December	8	0

Source: DFWP 1986b.

[a] Updated EPA criteria for copper are more stringent that those used in calculations for this table; thus, it is possible that a slightly greater percentage of samples will exceed the updated criteria.

Table D-3. Results of instream bioassays in the upper Clark Fork basin.

Station	Percent of fish that died during the study	Percent of test period during which criteria for protection of aquatic life was exceeded. Copper	Zinc
Silver Bow Creek	89	100	100
Clark Fork at Warm Springs	25	100	60
Clark Fork at Bearmouth	21	80	60
Clark Fork at Deer Lodge	15	100	60
Clark Fork at Gold Creek	7	70	30
Clark Fork at Clinton	3	40	20
Racetrack Creek	0	---	---

Source: Phillips 1987.

Table D-4. Number of days in June, July, and August (1977-82) when median daily water temperature exceeded 66 degrees F at several locations along the Clark Fork.

Locations	Years of Data	Number of Times Exceeded Total	Number of Times Exceeded Per Year
Deer Lodge	3	17	5.6
Gold Creek	4	85	21.3
Bearmouth	5	106	21.2
Bonita	5	115	23.0
Clinton	3	86	28.6

Source: DFWP 1986b.

Table D-5. Locations and dates of dissolved oxygen measurements in the Clark Fork when concentrations below 7.0 mg/l were recorded.

Location	Date	Minimum recorded (mgl)
Deer Lodge	August 3, 1973	5.9
Drummond	August 3, 1973	6.0
Bonita	August 3, 1973	5.2
Turah	August 3, 1973	6.0
Deer Lodge	July 21, 1976	6.8[a]
Deer Lodge	July 21, 1977	6.0[a]
Bonita	July 21, 1977	5.9
Deer Lodge	August 4, 1977	6.4[a]
Bonita	August 4, 1977	6.8
Deer Lodge	August 18, 1977	6.2[a]
Bonita	August 18, 1977	6.3

Source: Montana DFWP 1986b.

[a] DHES classifies the Clark Fork at Deer Lodge as a C-2 stream which allows dissolved oxygen levels to fall no lower than 6.0 mg/l from June 2 to September 30.

Table D-6. Irrigable acreages in the upper Clark Fork basin.

Drainage	Full service Acres not considering water availability[a]	Full service Acres taking water availability into consideration
Clark Fork		
Bonner-Rock Creek	348	348
Rock Creek-Drummond	268	268
Drummond-Gold Creek	963	963
Gold Creek-Garrison	195	195
Perkins Creek	-0-	-0-
Warm Springs Creek	-0-	-0-
Carten Creek	-0-	-0-
Garrison-Deer Lodge	2,976	2,976
Mullan Gulch	-0-	-0-
Willow Creek	-0-	-0-
Deer Lodge-Warm Springs	1,248	1,248
Warm Springs Creek	-0-	-0-
Lost Creek	-0-	-0-
Racetrack Creek	-0-	-0-
Caribou Creek	-0-	-0-
Peterson Creek	-0-	-0-
Dempsey Creek	-0-	-0-
Cottonwood Creek	-0-	-0-
Fred Burr Creek	-0-	-0-
Tin Cup Joe Creek	-0-	-0-
La Marche Creek	-0-	-0-
Barker Creek	-0-	-0-
Twin Lakes Creek	-0-	-0-
Flint Creek		
Drummond-Maxville	360	360
Lower Willow Creek	-0-	-0-
Maxville-Georgetown Lake	442	442
North Fork Flint Creek	-0-	-0-
Silver Creek	-0-	-0-
Boulder Creek	-0-	-0-
Little Blackfoot		
Garrison-Headwaters	1,042	1,042
Dog Creek	134	134
Snowshoe Creek	-0-	-0-
Trout Creek	-0-	-0-
Carpenter Creek	-0-	-0-
Six Mile Creek	-0-	-0-
Telegraph Creek	386	386
Total	8,362	8,362

Irrigable acreage along tributaries of Flint Creek.

Henderson Creek	446	-0-
South Fork Lower Willow Creek	182	-0-
West Fork Lower Willow Creek	142	-0-
Lower Willow Creek	179	-0-
Cow Creek	2,203	-0-
Marshall Creek	325	-0-
Total	3,477	-0-

Irrigable acreage along tributaries of the Little Blackfoot River.

Spotted Dog Creek	480	-0-
Trout Creek	576	-0-
Telegraph Creek	467	-0-
Snowshoe Creek	1,094	-0-
Carpenter Creek	518	-0-
Six Mile Creek	806	-0-
Gimlet Creek	557	-0-
Three Mile Creek	1,267	-0-
Total	5,765	-0-

Source: DFWP 1986.

[a] A zero indicates no irrigable land was found on this tributary.

Table D-7. Acreage values for irrigated lands in the upper Clark Fork drainage.

River Peach	Irrigated Acres
Clark Fork	
Bonner-Rock Creek	1,708
Rock Creek-Drummond	2,236
Drummond-Gold Creek	2,841
Perkins Creek	34
Gold Creek-Garrison	483
Gold Creek	1,506
Warm Springs Creek	52
Carten Creek	19
Garrison-Deer Lodge	2,992
Mullan Gulch	1,571
Willow Creek	553
Deer Lodge-Warm Springs	6,185
Warm Springs Creek	1,255
Lost Creek	4,572
Racetrack Creek	8,155
Caribou Creek	1,507
Peterson Creek	1,046
Dempsey Creek	1,727
Cottonwood Creek	926
Fred Burr Creek	4,602
Tin Cup Joe Creek	1,109
La Marche Creek	3,196
Barker Creek	--
Twin Lakes Creek	--
Flint Creek	
Drummond-Maxville	7,295
Lower Willow Creek	5,983
Maxville-Georgetown Lake	9,698
North Fork Flint Creek	5
Silver Creek	20
Boulder Creek	--
Little Blackfoot	
Garrison upstream	4,265
Dog Creek	447
Snowshoe Creek	758
Trout Creek	604
Carpenter Creek	532
Six Mile Creek	4,137
Total	82,019

Table D-8. Sample size of Hagmann's upper Clark Fork study.

Type of Recreationist	Recreationists Observed	Recreationists Interviewed
Montana resident	1,873	689
Out-of-state resident	615	297
Residence unknown	836	0
Total	3,324	986

Table D-9. Percentage of recreationists participating in selected activities in the upper Clark Fork study area.[a]

	Resident	Non-Resident	Total	Activity Engaged in most
Activity	Percent (N=689)	Percent (N=297)	Percent (N=986)	Percent (N=514)
Fishing	82.9	52.5	73.7	59.3
Rest or Relaxation	45.1	55.9	48.4	6.8
Walking or hiking	35.8	44.4	38.4	2.1
Picnicking	34.2	25.9	31.7	2.3
Sightseeing	26.3	41.8	30.9	2.1
Recreational vehicle camping	15.7	38.0	22.4	4.7
Water play	20.9	15.5	19.3	3.3
Tent camping or no cover	13.4	23.2	16.3	6.4
Floating	19.7	4.7	13.2	3.9
Fishing from a boat	10.4	3.7	8.4	3.1

[a] Percentages do not total 100 percent because respondents often participated in more than one activity.

APPENDIX E

COST ESTIMATES FOR NORTH FORK OF LOWER WILLOW CREEK DAM

DNRC used cost curves from the U.S. Bureau of Reclamation (USBR) to estimate the costs of the North Fork of Lower Willow Creek dam proposed by the Granite Conservation District. Cost indexes of new dam construction were taken from the Engineering News Record and applied to the USBR cost curves to derive an estimate of what the project would have cost in 1987. The DNRC estimates vary considerably from those projected by the Granite Conservation District. The major disparities are in the costs of the spillway and outlet works.

<u>Dam Volume</u>

GCD estimated that 501,000 cubic yards of fill would be necessary to build the dam for this project. DNRC's estimate of 480,000 cubic yards was based on topography of the site and the probable dam cross section, but probably was too low because it did not consider the extensive foundation work that would be required for the south 80 percent of the structure. USBR data indicate the dam would require 1.18 million cubic yards. For cost estimation purposes, DNRC used 500,000 cubic yards.

<u>Embankment Costs</u>

Small dam projects such as the proposed North Fork of Lower Willow Creek dam typically have higher costs per volume of embankment, primarily because of the economies of scale. It is cheaper per yard to move 10 million cubic yard of dirt than 1 million cubic yards. GCD estimated a cost of $2.50 per cubic yards of fill. Indexed to 1987 costs, the USBR embankment cost curve indicated the cost would be $7.26 per cubic yard. Recent estimates for work on the dam at Chessman Reservoir near Helena range from $4.85 to $7.50 per cubic yard. DNRC used $5.25 per cubic yard as a reasonable estimate.

<u>Outlet Cost</u>

GCD estimated the outlet works would cost $65,000. Based on the estimated 113 feet of head and 116 cfs flow, the USBR curve indicates the 1987 cost of the outlet works would be $1,112,940.

<u>Spillway Cost</u>

GCD calculated the Probable Maximum Flood at the North Fork of Lower Willow Creek to be 7,926 cfs. The GCD spillway cost estimate was $555,000. Application of the USBR curve to GCD's flow estimate and indexing up to 1987 indicates the spillway would cost $3,620,980.

COST ESTIMATES

		GCD		DNRC
Embankment		$1,252,500		$2,625,000
Outlet		64,500		1,112,940
Spillway		555,000		3,620,980
	Subtotal	$1,872,000		7,358,920
Contingency @ 20%		374,400	@15%	1,103,838
	Subtotal			8,462,758
Engineering, Legal, Administration @ 15%[a]		365,000	@10%	846,276
	Subtotal			9,309,034
Hidden Costs @10%		187,200	Financing @5%	465,452
	Subtotal			9,774,486
Interest @?%		60,800[b]	@2%	195,490
TOTAL ESTIMATED COST		$2,859,400		$9,969,976

[a] Includes hidden costs.
[b] GCD 1987.

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Engineer, Washington Water Power Company, Spokane. Telephone conversation (December 9) with Jim Boyer, socioeconomist, Montana Department of Natural Resources and Conservation, Helena.

LIST OF PERSONS PREPARING EIS

John Tubbs, Economist	Project Coordination
Tom Ring, Environmental Specialist	Aquatics, Project Coordination
Kevin Hart, Environmental Specialist	Historical and Cultural Concerns
James Boyer, Environmental Specialist	Social and Economic Concerns
Art Compton, Environmental Specialist	Land Use Concerns
Dan Dodds, Economist	Need and Alternatives, Economics
Nancy Johnson, Environmental Specialist	Aesthetic and Recreation Concerns
Scott McCollough, Environmental Spec.	Wildlife Concerns
Earl Griffith, Environmental Spec.	Soils, Geology, Engineering Concerns
Steve Holnbeck, Hydrologist	Hydrological Modeling
Steve Sando, Hydrologist	Hydrological Modeling
Will Harmon	Editor
Daniel Vichorek	Editor

REVIEWERS

Larry Fasbender, DNRC Director
Dave Darby, DNRC Deputy Director
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Van Jamison, Energy Division Administrator
Alan Davis, Chief, Planning and Analysis Bureau
Gary Fritz, Water Resources Division Administrator
Gerhard Knudsen, Water Planning Section Supervisor
Rich Moy, Chief, Water Management Bureau

CLERICAL

Joanne Brown, Word Processor
Emelia Satre, Word Processor
Margie Peterson, Word Processor

GRAPHIC ARTS

Gordon Taylor, Chief, Cartography Bureau
June Virag, Maps, Illustration
Don Howard, Illustration, Cover

MONTANA DEPARTMENT OF
NATURAL RESOURCES & CONSERVATION

1520 EAST SIXTH AVENUE
HELENA, MONTANA 59620-2301

300 copies of this public document were published at an estimated cost of $7.00 per copy, for a total cost of $2,100.00, which includes $2,100.00 for printing and $.00 for distribution.